A TREATISE

ON

REGIONAL SURGERY

VOLUME I

BINNIE

VOLUME I

VOLUME II

VOLUME III

The section on The Thoracic Walls, Lungs and Pleuræ will be in Volume III.

The second part of The [illegible] will be in Volume III

A TREATISE
ON
REGIONAL SURGERY

BY VARIOUS AUTHORS

EDITED BY

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KANSAS CITY, MISSOURI

VOLUME I

WITH 351 ILLUSTRATIONS

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PREFACE

General surgery deals with certain principles of pathology and therapy which apply to all fields of the art, but does not concern itself with the peculiarities of disease and injury when these affect particular regions or organs. A knowledge of general surgery is a *sine qua non*, but once the student is well grounded in the principles of his art it becomes essential for him to know its application and to afford this knowledge is the province of Regional or Special Surgery.

The aim of the present work is to present short treatises on the injuries and diseases of the different regions of the body.

To each of the authors who kindly consented to contribute the editor sent an estimate of the length of the article desired along with a request that the contents be practical and consist of the opinions of the author himself and not a statement of what "he thought other people would think that he ought to think." The authors were further invited to use illustrations wherever they deemed such necessary to *illustrate* their text but not for merely decorative purposes.

In the following pages one can judge how the individual authors interpreted and carried out these requests, as the Editor has not presumed to interfere in the slightest degree with the material contained in the various chapters.

In a work of this character there is bound to be some overlapping. When overlapping or repetition occurs it is interesting and instructive to note the differences in the views expressed by the different authors. No apology is offered for this repetition—to the Editor it seems an advantage.

There was so much difficulty in securing a suitable authority to write a chapter on the diseases of the brain that, rather than insult the reader with a piece of 'hack work,' the Editor chose to omit it entirely.

Dr. James E. Logan was good enough to assist the Editor in obtaining authors to undertake the chapters on the Nose, Pharynx and Ear. Thanks are due to Drs. R. M. Schauffler, C. B. Francisco, John G.

Hayden, H. S. Valentine and Mrs. C. M. Bossler for generous assistance in proof-reading, etc.

For the plan of the work the Editor is responsible; for its execution the responsibility lies with the Surgeons of America, Britain and far off Australia, who so kindly consented to help him

J. F. B.

LIST OF CONTENTS

SECTION XI

REGIONAL SURGERY

THE HEAD

SECTION I

TRAUMATA OF THE SCALP

By

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New York

Anatomy.—The scalp is made up of all the soft parts covering the bony vault of the skull. It may be divided into five layers:

1. The skin, the thickest in the body, is closely bound to the galea aponeurotica into which the occipitofrontalis muscle is inserted, hence it moves with these muscles.
2. The subcutaneous layer (or superficial fascia) consists of a large number of strong fibrous bands, binding together the skin and aponeurosis and forming a multitude of small compartments, containing lobules of fat. The blood-vessels and nerves supplying the three layers of the scalp are subcutaneous instead of subaponeurotic, and are so closely connected with the fibrous partitions that, when divided in wounds of the scalp, they are often unable to contract, hence hemorrhage is profuse and not liable to stop spontaneously. It is sometimes difficult to clamp the vessels in the dense fibrous tissue, hence a suture ligature may be at times the best means of stopping the hemorrhage. The hair bulbs extend into the subcutaneous layer and are so firmly attached that the weight of the body may be sustained by the hair. Instances are numerous where the hair has been caught in the wheels of a machine, causing the tearing of more or less of the scalp from the skull; avulsion of the scalp.
3. The aponeurotic layer, or galea aponeurotica, consists of an aponeurosis extending between the anterior and posterior portions of the occipitofrontalis muscle.

4. The subaponeurotic areolar layer consists of loose connective tissue which allows considerable movement of the superficial scalp upon the pericranium. This looseness of attachment permits the gaping of scalp wounds and the easy separation of large flaps of scalp in injuries, operations, scalping by Indians or autopsies. Wounds of the scalp do not gape unless the occipito-frontalis or aponeurosis be divided and the greatest gaping occurs where the division has been transverse to the direction of the muscle fibers. Treves has called this layer the "dangerous area of the scalp" because of the wide and rapid spread of suppuration, posteriorly, as far as the superior curved line, anteriorly, to the superciliary edges and laterally to or even below the level of the zygoma.
5. The pericranium (or external periosteum) is very slightly adherent to the bone beneath, except at the sutures and foramina where it is continuous with the dura; hence the danger of inflammation of the pericranium extending to the dura. Owing to the attachment of the pericranium to the sutural membrane, hematomata and abscesses are usually limited to the area of one bone. In extensive scalp wounds, the pericranium may be widely stripped from the bone beneath without causing necrosis of the bone which derives its blood supply from the vessels of the diploë and dura.

The vessels of the scalp are large, rendering the living of very large flaps almost certain. The arteries are subcutaneous, instead of being subfascial, as is the case in other situations in the body. They are arranged in pairs: two anterior, the frontal and supraorbital, both branches of the ophthalmic; two lateral, anterior and posterior temporals, both branches of the temporal, itself a branch of the external carotid; two posterior, the posterior auricular and occipital, each a branch of the external carotid. All the arteries go from base to apex, freely anastomose and form a complete network.

The veins of the scalp are of three classes:

1. Superficial, accompanying the corresponding arteries in the subcutaneous tissue.
2. Diploic, traversing the diploë, which is the spongy osseous tissue between the two tables of the skull. These veins communicate with the venous sinuses internally, and the superficial veins externally by means of the emissary veins.

3. Emissary, which pass through foramina in the skull and establish communication between the veins of the scalp and the sinuses. The three most important emissary veins are:
   (*a*) The vein passing through the mastoid foramen and connecting the lateral sinus with the occipital or posterior auricular vein. Leeches applied behind the ear may thus abstract blood directly from the intracranial circulation.
   (*b*) The vein traversing the posterior condylar foramen and connecting the sigmoid sinus with the deep veins at the back of the neck.
   (*c*) The vein which passes through the parietal foramen to reach the superior longitudinal sinus.

There are also many minute veins which connect the veins of the scalp with the veins of the diploë. Through the emissary veins infections of the scalp may be carried to the bones, sinuses, meninges and brain. The anastomosis between the angular and supraorbital veins at the inner angle of the orbit, brings about a free communication between the extra- and intracranial circulation, since the supraorbital vein through the ophthalmic is a tributary of the cavernous sinus. If there were no emissary veins, injuries and diseases of the scalp would lose half their seriousness (Treves).

The lymphatics of the scalp form three distinct groups:

(*a*) The anterior parietal and frontal empty into the parotid nodes. Some of the frontal vessels join the lymphatics of the face and end in the submaxillarly ganglia.
(*b*) The posterior parietal empty into the mastoid nodes.
(*c*) The occipital lymphatics pass directly back and empty into the suboccipital ganglia, although a few may reach the ganglia under the sternomastoid.

Wounds.—Scalp wounds are ordinarily classified as:

(*a*) Contused.
(*b*) Incised.
(*c*) Punctured.
(*d*) Lacerated.

Contusions may be made by either glancing or direct blows, which produce hemorrhages in the various layers. The hematomata caused by direct blows are usually small, hard, circumscribed, subcutaneous swellings, which can be moved with the scalp. In the case of glancing blows, hematomata into the deeper layers are produced by the tearing away of the scalp from its subaponeurotic attachments (subaponeu-

rotic hematoma) or of the pericranium from the bone beneath (subpericranial hematoma). Subaponeurotic hematomata may be large in extent, due to the blood dissecting along the areolar tissue between the aponeurosis or muscles and the pericranium. Absorption of the blood is often very slow. Near the periphery of the hematoma the blood soon clots and the tissues are densely infiltrated; thus the soft center of the hematoma is surrounded by a hard, elevated rim. To the examining finger the soft center of the hematoma feels like a depression in the bone and may mislead even the most experienced.

In favorable cases firm pressure with the finger may make the hard rim disappear and show the skull to be smooth and free from depression.

Non-absorption of a hematoma may result in the formation of a blood cyst.

Occasionally the skin over the swelling becomes gradually thinned out and may ultimately give way. In other cases, particularly when the skin has been broken, suppuration may take place.

Subpericranial Hematomata.—With advancing years the pericranium loses in large part its abundant vascular attachments to the skull and thus, while subpericranial hematomata are common in infants, they become less and less common as age advances. The extravasation is usually limited by the sutures and does not extend beyond the particular bone over which it first occurred. The mistaken diagnosis of a depressed fracture is more common here than in the subaponeurotic variety, for absorption of the blood may fail (forming a blood cyst) and, around the thickened edges, the elevated pericranium may produce a rim of new bone. The absence of signs of cerebral compression, when the bone in the center of the swelling is pressed upon, implies that the case is one of subpericranial hematoma, rather than one of depressed fracture. In both the subaponeurotic and subpericranial hematomata, if a large arterial vessel be torn, the tumor may pulsate but this is rare. New bone formed in a hematoma may persist and form a bony protuberance, an osteoma of the skull.

Treatment of Hematomata.—If the skin be broken, the first necessity is careful disinfection of the scalp over the swelling, particular attention being paid to the wounded surface. It is safest to clip the hair short and then, without any previous washing, to disinfect, by the application of tincture of iodine, the inside of the wound and then the surrounding scalp. To limit the spread of the effusion, pressure should be applied at the earliest moment after the injury by the application of an elastic bandage over a small mass of cotton wool which

somewhat overlaps the hematoma. For 24 or 48 hours it is wise to apply an ice bag over the pressure bandage which may help to limit the effusion. Ice cold should not be used longer than this time, since it lowers the vitality of the tissues.

If absorption goes on steadily, pressure may be kept up until all the blood is absorbed; this may require two weeks or more. If absorption comes to a standstill despite the above treatment, the central portion of the swelling may remain fluid and a blood-cyst form. In such cases the cure may be hastened by aspirating the liquid blood by means of a large-sized needle, after very careful sterilization of the site of puncture. If it is impossible to withdraw the fluid through the needle on account of its thickness, it may be evacuated through a very small incision or puncture, at the same time removing any coagula with a sharp spoon. The cyst should not ordinarily be drained for fear of infection. In some few cases the fluid may re-accumulate, and in such a condition it may be necessary to insert a small rubber drainage tube through a small incision in the most dependent portion of the cyst. Absolute asepsis must be most carefully carried out.

Cephal-hematoma.—This is to be distinguished from a caput succedaneum, which latter is present at the time of birth and is a serous infiltration of the superficial structures of the scalp, due to venous stasis. It corresponds in position to the external os and disappears in two or three days. A caput succedaneum does not conform in outline to one of the bones as does a cephal-hematoma; it can be pitted on pressure and does not fluctuate.

A cephal-hematoma is a subpericranial effusion of blood, distinctly confined by the boundaries of one of the cranial bones, usually the parietal, more rarely the occipital bone. It occurs about once in 200 births and may be bilateral. Usually two or three days after delivery a swelling develops, rapidly increases in size and presents the signs of a cystic tumor.

A cephal-hematoma is due to the temporary indentation of a bone, causing a tearing away of the bone from its highly vascularized pericranium, or by the overlapping of the bones of the skull, causing injury to the blood-vessels. The pericranium may subsequently produce new bone, giving rise to a peculiar crackling or crepitus over the surface of the tumor. Cushing mentions the rare occurrence of extradural cephal-hematoma without any subpericranial effusion. This is a true hematoma under each parietal bone. In serious injuries, therefore, he says it is possible to have three layers of extravasation, subpericranial,

extradural and subdural, the last being due to rupture of cortical vessels.

Anything which causes congestion, such as crying or straining, or the venous stasis produced by intracranial hemorrhage, will tend to increase the swelling markedly. Cephal-hematomata usually last from one to two weeks, when they begin to subside. In rare cases a cystic condition may result, producing a swelling which may last through life. Occasionally the clot becomes infected, giving rise to an abscess which may lead to necrosis of bone and intracranial suppuration.

Diagnosis of Cephal-hematomata.—This is ordinarily easy even if, as is unusual, the swelling is present at birth and is surrounded by a caput succedaneum, which is still more rare. A caput succedaneum rapidly subsides while a cephal-hematoma increases in size and persists for at least several weeks. A spurious meningocele may have the same position but it pulsates with cardiac and respiratory movements, and is reducible, as is also a *sinus pericranii*, which is usually situated in the middle line.

Treatment of Cephal-hematomata.—Cleanliness and moderate pressure, applied by means of a bandage, usually suffice but if after two weeks the swelling does not diminish, operation becomes advisable to avoid the danger of subsequent infection or the production of a permanent deformity. After shaving the head and disinfecting with tincture of iodine make a small vertical incision at the lowest part of the swelling. The injection of a few drops of a local anesthetic (novocaine 2 per cent.), renders the incision painless. By pressure or by the use of a curette, evacuate the blood, both clotted and liquid. Neither drainage nor sutures should be used. Apply a dressing under moderate pressure.

Pneumatocele cranii is a rare gaseous tumor which appears under the scalp, either in connection with the air-containing mastoid cells or the frontal sinuses. There is often a previous history of direct violence or of infection by which part of the thin layer of bone under the pericranium has been destroyed without injury to the membrane itself. The pericranium is detached and ballooned out by an increase in pressure transmitted through the Eustachian tube to the mastoid cells or through the infundibulum to the frontal sinuses.

The affection may be bilateral and is easy of recognition, owing to the tympanitic tumor. The surgical treatment consists in the free opening of the tumor and the denudation of its walls so as to form fresh

surfaces, which it is hoped will subsequently adhere under the pressure of a snug bandage.

Sinus pericranii (Stromeyer) is a collection of fluid blood, producing a cystic tumor, situated usually near the mid-line of the skull and under the pericranium. It is often of traumatic origin and the resulting extracranial blood sac communicates with the longitudinal sinus through a canal in the skull. The swelling is reducible on pressure, is rarely larger than a walnut, and is soft and elastic. The size and tension of the swelling are increased by coughing or straining.

Treatment of Sinus Pericranii.—If the affection is the result of increased intracranial pressure due to a brain tumor, removal of the tumor or a decompression operation may cause its disappearance. If due to other causes the sac should be opened and the canal through the skull obliterated by plugging with Horsley's wax or a fragment of muscle or by crushing its walls together with rongeur forceps.

Meningocele spuria or cephalo-hydrocele traumatica (Bergmann) is never the result of injuries of the soft parts of the head alone, so will not be considered here.

Wounds of the Scalp.—While the scalp may be the site of ordinary incised and punctured wounds, yet contused wounds are much more common. If a hand wearing a well-fitting kid glove is struck with a blunt instrument the glove splits and gives the appearance of having been cut—in the same way a blow from a blunt instrument may cause splitting of the scalp, the result being practically a combination of incised and contused wounds. Owing to its loose connection with the skull the scalp may be partially or completely torn away. The art of scalping was perfected by the Indians but in modern times the avulsion of the scalp is most commonly the result of the hair being caught in rapidly moving machinery. A sliding blow sustained in a fall may rub the scalp off the bone and at the same time grind dirt into all parts of the wound. It must be remembered that when a person falls on to the ground from a rapidly moving conveyance he hits the ground not only with the force of gravity but with the horizontal momentum communicated to him by the vehicle; thus he not only hits the ground but scrapes or slides along it with sufficient friction to produce much heat. The result may be a contusion, laceration and burning of the scalp.

Hemorrhage may be very free even in comparatively superficial wounds as has been already explained. When there is much laceration the bleeding is liable to be less than when the wound is clean cut.

Punctured wounds are not so common. Blows which produce them are more likely to be glancing and to slice off a flap of scalp. The bony skull may likewise be penetrated. The tract should be disinfected by carrying in tincture of iodine on a small cotton swab and drained with a slip of rubber tissue. On the slightest sign of any deep suppuration, the tract should be laid open and packed. A knife blade introduced into the temporal region may be broken off above the zygoma and produce serious hemorrhage. Very exceptionally ligation of the external carotid may be required to stop the resulting hemorrhage.

More or less laceration and bruising are commonly associated with scalp wounds, in fact a blow with a blunt instrument is the commonest cause of what is apparently an incised wound of the scalp.

Treatment of Scalp Wounds.—In all scalp wounds there are three points which have to be attended to:

1. The arrest of hemorrhage.
2. The disinfection of the wound.
3. The union of the cut edges.

According to their severity scalp wounds may be divided into three groups with respect to treatment:

1. Those in which the wound passes only through the subcutaneous tissues.
2. Those in which either the aponeurosis or the pericranium or both are divided.
3. Those in which considerable portions of scalp are detached.

Treatment of superficial wounds. Remove the hair from around the wound by clipping or dry shaving. Remove oil or grease by washing with benzine. After the benzine has evaporated paint the wound and the surrounding skin with tincture of iodine. Remove all visible foreign matter from the wound. Close the wound with interrupted sutures of horse-hair or silkworm gut. Hemostasis may be secured by the pressure of a bandage on the dressings. All sutures should be removed by the fifth day or earlier if they are causing irritation. If the wound becomes infected all stitches must be removed and it must be treated as an open wound.

When the occipito-frontalis muscle or the aponeurosis is divided, especially if the division is transverse, there is considerable gaping of the wound. If hemorrhage is severe enough to interfere with proper disinfection of the wound it may be controlled by a rubber band or tube passed two or three times around the skull from the glabella to

beneath the occipital protuberance. This tourniquet may be removed after dressings have been applied to the wound.

Permanent hemostasis may be secured by ligatures usually applied as stitches around the vessels or by the pressure of a bandage over the dressings after the wound has been closed with sutures. When there is much laceration of the edges of the wound these may be pared with knife or scissors. If the bone is soiled it may be advisable to chisel off a thin layer of its surface, taking care, however, not to open the diploë, and then to disinfect it with iodine or with pure carbolic acid, neutralized immediately with alcohol. The wound is closed with interrupted sutures, preferably of silkworm gut; these should be introduced as far apart as possible and should involve the aponeurosis and pericranium, if these structures are divided. Except in very dirty wounds drainage is unnecessary; when it is necessary it may be provided by the introduction of narrow strips of rubber tissue. All scalp wounds ought to be carefully watched so as to anticipate the spread of infection. If the scalp has been torn away from the head and has been promptly recovered, it may be replaced, after cleansing both it and the bed from which it was torn with a solution of tincture of iodine, one-quarter the official strength. The flap may be held in position by a few sutures. Even when the re-implantation is fairly successful parts of the flap often necrose, necessitating subsequent skin grafting.

Infections.—Diffuse cellulitis of the subaponeurotic layer is one of the commonest results of scalp wounds, especially those which are particularly soiled and those which are inadequately cleansed and disinfected. Deep-closed wounds may appear to be healing without reaction for two or three days when the incidence of tenderness and edema of the tissues with fever and increased rapidity of the pulse show the presence of infection. Unless the wound is opened sufficiently to let out the inflammatory products, serious results may occur. Infection in the loose aponeurotic layer, having no natural outlet, may spread widely. The pericranium, even if it be not torn by the original injury, becomes involved, sloughs away, and the bone beneath is liable to become infected. The resulting osteomyelitis may affect only the outer table of the skull or it may invade the diploë and inner table and large areas of the calvarium may necrose and sequestrate. Even in less severe processes, infection may travel through the diploic vessels to involve the cranial sinuses or infect the cerebro-spinal fluid. If the infection has spread, free vertical incisions must be made through the occipito-frontalis aponeurosis and drainage tubes inserted. The

incisions should extend beyond the inflammatory area. Boric fomentations should be applied, and in bad cases irrigation may be employed, the head and neck being surrounded by a mackintosh in such a way as to carry off the fluid without soiling the bed. When the inflammation has begun to subside, the irrigation may be discontinued and wet antiseptic dressings substituted for it.

Subpericranial abscesses are usually limited to the surface of a single cranial bone, due to the pericranial attachments. They are often due to the secondary infection of a cephal-hematoma, from operative interference or from a hematogenous source. These abscesses are often secondary to osteomyelitis, particularly mastoid disease.

In extensive infections of the scalp, a large defect may result. The healing of such a defect may be hastened materially by skin grafting.

Erysipelas was formerly a very common complication of even small scalp wounds. When the disinfection of the scalp wound is thoroughly performed, it is a very rare complication. Erysipelas of the scalp does not manifest itself as elsewhere in the body. On account of the density of the subcutaneous tissues, the usual sharp demarcation with redness and elevation of the skin are largely absent. Hence it may not be recognized until its edge reaches the forehead. The gravity of erysipelas in this region is due to the possibility of the inflammation spreading to the meninges or to the diploic veins. The treatment does not differ from that of erysipelas elsewhere in the body.

SECTION II.

DISEASES OF THE SCALP

By

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The common infections of the scalp have been sufficiently discussed in the chapter on Traumatisms.

Furuncles and carbuncles are frequent about the junction of the scalp and neck. Such lesions as eczema, seborrhœa, favus, tinea, etc., hardly belong to a work on surgery.

Tuberculous ulcers of the scalp may occur secondarily to lesions of the skull. Lupus is rare except as an extension from the face.

Syphilitic Lesions of the Scalp.—Secondary macules, papules and pustules are common. When they are situated along the hair margin above the forehead they constitute the "corona veneris."

Alopecia syphilitica belongs to the early secondary stage of the disease. The hair may come out in patches but usually is merely thinned; it rarely leads to baldness and is a much over-rated symptom of syphilis.

Gummata.—In the later stages of syphilis, nodules may appear in the scalp especially in the forehead. These nodules may be flat or prominent, have a bluish-red surface and are arranged in groups. They are painless and have a marked tendency to break down leaving punched out, dirty ulcers which spread peripherally. The disease spreads by the breaking down of fresh nodules near the original ulcer which tends to heal; hence the serpiginous form of the ulcer which permits a diagnosis being made at a glance. König draws attention to the fact that large ulcers with smooth floors of granulation tissue may develop on the basis of the multiple skin nodules, be resistant to almost any treatment and show a marked tendency to hemorrhage because of their rich blood supply.

Tumors of the Scalp.—Hertzler remarks, "the cranial region may be called the oncological museum of the body, since almost every known tumor may be encountered here either as a primary growth or as a metastasis of a growth in a distant organ."

Wens; Atheromata; Sebaceous Cysts.—Owing to the plugging of its duct, a sebaceous gland becomes distended with a collection of cheesy sebaceous material. Connective tissue around the gland becomes condensed into a capsule for it. Thus a cyst forms *in* the skin; only by extension does it invade the subcutaneous tissues. The tumors vary in size from a pea to an orange—usually they are about the size of a marble. The skin covering them is smooth and hairless. The tumors are never attached to the skull, thus differing from meningoceles and they are usually found in adults, thus differing from dermoids which are more common in adolescents. Wens grow slowly and are painless; occasionally they become infected and result in abscess formation. Unless the sac of the cyst is destroyed by the inflammation or removed by the surgeon, the inflammation is likely to be recurrent. Occasionally an epithelioma develops on the basis of an irritated wen.

Treatment.—(*A*) Make an incision into the cyst nearly as long as the diameter of the tumor. Seize the cyst wall with a strong forceps (hemostat) and with a twisting motion pull out the whole sac.

Close the wound with a few sutures.

(*B*) Expose the tumor through crescentic incisions and dissect it out without opening it.

Dermoid cysts are of congenital origin, are lined by a membrane allied to skin and contain oily material, epithelial detritus and hair. The cysts arise at the lines of union of the developing cranium and hence are most common at the temples, root of nose, orbit or over the fontanelles. The tumors are smooth and hemispherical swellings with fixed base but the skin is movable over them. The bone under and around their base may be deficient or absent. The tumors *may* pulsate but they do not disappear on pressure. While dermoids are always congenital they may not be noticed until the second or third year and are apt to develop rapidly about the time of puberty.

Treatment.—Excision if necessary.

Lipomata.—Fatty tumors of the scalp are rare and when they do occur they are usually situated in the frontal or temporal regions. They lie *under* the aponeurosis, are never adherent to the skin and form flattened, soft, elastic prominences. Owing to a thickening of the periosteum round a lipoma, it appears on palpation to lie in a depression in the skull. Occasionally when a lipoma is large it may so drag on its base as to form a distinct pedicle.

Treatment when required is excision.

Papillomata; Warts; Moles.—Pigmented nevi are common on the scalp. Pigmented or hairy moles and warts are sometimes the starting-point of melano-sarcoma and of epithelioma respectively. It has been observed that when pigmented moles are multiple they are less liable to malignant degeneration than when single and also that a mole on the temple is to be looked on with more suspicion than one situated elsewhere on the scalp.

Often no treatment is required but when there is much disfigurement or irritation, or where subsequent malignancy is dreaded, excision may be obligatory.

In flat moles application of carbon-dioxide snow may be curative and leave little or no scar. In hairy moles Pusey has destroyed the hair by exposure to the X-rays and then removed the pigmented tissues with the snow.

Carbon-dioxide gas may be obtained in tanks. Permit a spray of the gas to play into a bag of chamois leather. Snow is at once formed. Put the snow into a cylindrical mould and tamp it down firmly with a stick or pestle. Remove the firm candle of snow from the mould and trim it to the desired shape with a knife. Apply the snow candle with moderate firmness for a few seconds to the part to be treated. The application may require to be repeated two or three times at intervals of about one week.

Cutaneous horns may arise from a wart or a sebaceous cyst and consist of stratified layers of horny epithelium. They may be multiple, are very disfiguring and may undergo malignant changes. Treatment is excision.

Fibroma molluscum when involving the scalp is usually merely a part of a more generalized process. True *fibromata* occasionally appear on the scalp and may be of very large size.

Scar keloid is a form of fibroma arising from a pre-existing scar. It is very common in negroes.

While the treatment of fibromata is excision it is practically useless to excise scar keloids because of their tendency to recur in a more extensive form.

Elephantiasis Nervorum.—Plexiform neuroma has its favorite site in the temporo-frontal region. It is usually part of a generalized neurofibromatosis. The tumor usually appears in young adult life; often its starting-point is a pre-existing fibroma molluscum or a mole. "It is first evidenced by a thickening and loosening of the subcutaneous tissues, so that the scalp may be moved with greater readiness upon the

skull. Finally, of its own weight, it begins to sag, drawing down the outer canthus and crowding the pinna downward until the ear stands out perpendicular to the skull, or becomes buried altogether under the hanging folds of the tumor mass, which may even reach as low as the shoulder. The hair over it becomes coarse and the skin roughened; it is difficult to keep the mass clean, owing to its folds and creases; ulcerations may result, and in advanced cases, with involvement of the eyelids, there is particular risk of losing the globe from suppuration. The tumors are painless and when uncomplicated by infection or degeneration—for they may become sarcomatous—may be carried for years, though reaching an enormous size.

Pathologically they are made up of a snarl of nerve fibers whose perineural sheaths have become greatly and irregularly thickened from an increase of fibrous tissue. The plexiform meshwork is encased in a loose, succulent, fibrous tissue, which for a long time led investigators to overlook the important part played by the nerves themselves in the make-up of these tumors.

Their recognition is not difficult, and once seen and handled they are never forgotten. The loose, flaccid tissue with its contained tangle of irregularly lobulated, cord-like masses has been likened to the feel of an atrophic and pendulous mamma. The diagnosis is easy even in the absence of other skin lesions common to the disease. Unless too far advanced or too widespread, their treatment should consist of early removal. They rarely if ever extend below the aponeurotic membrane and may be completely extirpated. The chief dangers lie in the possibility of infection—for the surface may be hard to render aseptic—and in hemorrhage, particularly if only a partial removal can be attempted at one sitting, since they are apt to be vascular and the vessels in the spongy tissues will not hold clamps. Cases have been reported by Billroth and others in which a great number of separate operations were undertaken before complete removal was accomplished." (Cushing, Keen's Surg.)

Angioma simplex; port-wine stain; telangiectatic nevus is a congenital lesion composed of dilated capillaries and small blood-vessels. When entirely capillary it may cause no deformity except that due to its color but when larger vessels are present, whether arteries or veins, a tumor of more or less prominence is in evidence. The lesion presents all gradations of color from bright red to blue and, if arterial, may pulsate. While congenital the lesions are usually more prominent after four or five weeks than at birth.

Nevi may be so small as to be almost invisible or may involve large areas of the body. The uniformly pale red, flat nevus, not elevated over the level of the skin, frequently decreases or may even disappear spontaneously. Even those forms in which tumor is present may disappear, leaving a whitish scar but they usually increase in size.

Treatment.—In many cases disfigurement is so slight that no treatment is called for; in other cases the disfigurements incident to a cure might be worse than the disease. The most successful treatment of superficial angiomata without tumor formation, consists in the application of carbon-dioxide snow. Ignipuncture, electrolysis and the application of fuming nitric acid are all means of treatment inferior to freezing.

When tumor is present the treatment, when required, is usually operative.

Angioma cavernosum is a congenital lesion consisting of tissue similar to the corpus cavernosum penis. The tumors are compressible but rarely pulsating, often grow rapidly and may communicate directly with the intracranial vessels. Cavernous angiomata are generally suitable for excision except when they are suspected of communicating with intracranial vessels when they may better be subjected to ignipuncture.

Angioma-racemosum; plexiform angioma; cirsoid aneurism is a tumor consisting of a tangle of dilated arteries. It is sometimes congenital, sometimes traumatic in origin. It may grow rapidly, then remain stationary and later grow again. In severe cases there is great danger of hemorrhage being induced by ulceration or trauma. Cirsoid aneurisms vary much in size. (Fig. 5 shows an extreme example.)

Treatment of Angiomata.—The treatment of superficial nevi by freezing has been already described.

Ignipuncture.—Heat the point of a fine brad awl or similar tool until it is red hot, permit it to cool to a black color and then make it penetrate the angioma. After a few seconds remove the instrument, heat it again and introduce it at another spot. Application of fuming nitric acid may be effected by a method exactly the same as ignipuncture except that instead of heating the brad awl (a sharp wooden toothpick will serve) it should be dipped in nitric acid. McBride notes that the nitric-acid treatment is often followed by keloids.

The following methods of treating the more serious forms of angioma, *e.g.*, cirsoid aneurism, have been tried:

1. Pressure applied to the afferent vessels, no value.

2. Ligation of the afferent vessels, generally valueless.

3. Ligation of both common carotid arteries, rarely useful and always dangerous.

4. Injections of alcohol or of sesquichloride of iron have given some good results but the dangers are evident. Injections of boiling water are of equal value and present less danger.

5. Excision, where possible, is good.

Methods of Excision.—When simple nevi of the scalp require removal by operation, the incision must be made sufficiently far from the disease so that hemostasis may be easily effected; the wound, if extensive, may tax the resources of plastic surgery. Rapidly growing angiomata, those which penetrate the subcutaneous tissues or are large and tumor-like and those which bleed or threaten severe hemorrhage, all call for operation.

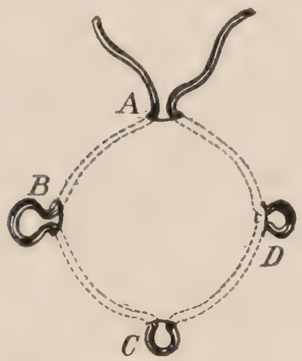

FIG. 1.—Subcutaneous ligation angioma.

Angiomata over the fontanelles often communicate with the longitudinal sinus; hence in these, radical operation should, if possible, give way to less vigorous measures such as ignipuncture. The same is true in the case of cavernous angiomata, which evidently penetrate the skull.

Methods of Operating. (*A*) *Strangulation.*—Pass a stout pin or needle under the middle of the nevus from side to side. Pass a stout thread around the base of the nevus under the pin (which keeps the thread from slipping). Tie the thread very tightly. Instead of one, two pins may be introduced at right angles to each other. In time the strangulated tissues die, slough off and leave an ulcer. In the twentieth century this treatment savors of barbarism.

(*B*) *Subcutaneous Ligation.*—Many methods of subcutaneous ligation have been used; most of them are exceedingly simple.

I. At the points A, B, C, D (Fig. 1) puncture the scalp with a knife. These points must be well away from the disease. With a needle introduce a stout chromicized catgut or a silk suture through A and bring it out at B, reintroduce it at B and bring it out at C; in the same manner carry the suture from C to D and from D to A. Both ends of the suture now emerge at A. Tie the suture tightly and let its knot retract under the skin through the puncture at A. Apply dressings.

II. Krogius ("Centralblatt für Chir.," Sept. 30, 1905) found that compression and ligation even, of the afferent vessels was inefficient in cases of large racemse (cirsoid) angiomata of the scalp; that igni-

puncture, injections and excisions were dangerous, he therefore operated as follows:

Arm a full curved needle with catgut. Pass the needle from A to B (Fig. 2), hugging the bone. Remove the full curved and substitute a less curved needle. With this pass the suture from B to A immediately under the skin (Fig. 3). Both ends of the suture now emerge at A. Tie the suture tightly.

Repeat the process all round the nevus until practically every vessel entering or leaving the tumor is controlled. Each suture or ligature should to some extent overlap into the territory controlled by the next one.

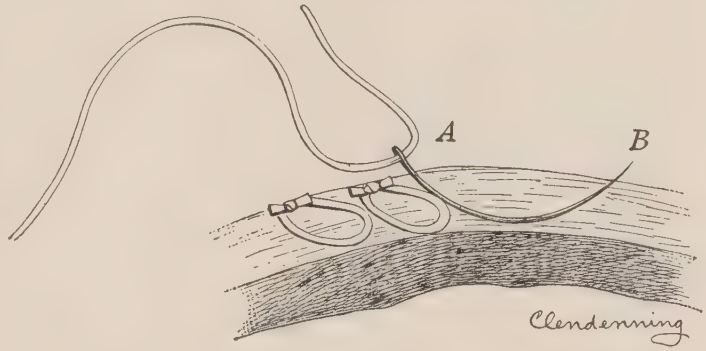

FIG. 2.—Krogius' operation angioma.

(*C*) *Bryant's Operation.*—Suitable in cases of cirsoid growth. Make an incision outside and nearly round the growth, down to the periosteum. Leave undisturbed that portion of growth containing the largest vessels. Raise the flap and attend to hemostasis. Apply dressings under, as well as over, the flap. When the wound is covered with granulations, replace and suture the flap. If after elevation of the flap for a few days pulsations continue in the flap (the tumor is in the flap), ligate at a distance the main vessel entering it. This method has given J. D. Bryant much satisfaction.

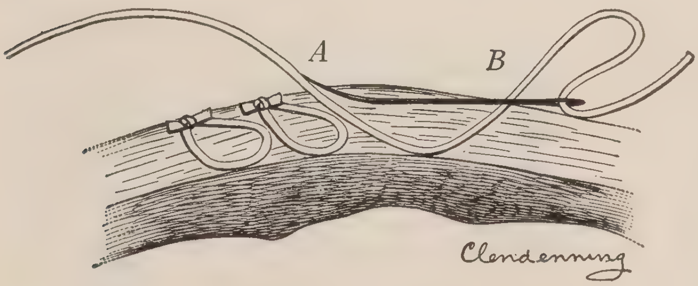

FIG. 3.—Krogius' operation angioma.

In a case of angioma of the lower frontal region the author operated as follows:

1. Shave the anterior portion of the scalp. Make a transverse incision over the head practically from ear to ear but inside the line of the hair.

2. Reflect the skin flap thus formed downward and forward until the angioma is almost reached (Fig. 4). At this point, if necessary, cut through the deeper structures until a layer of tissue is found beneath the angioma and continue the reflection of the flap downward in this plane until the lower limits of the angioma are passed. Working from the underside of the flap, pass sutures or ligatures around the main vessels entering the angioma from the base of the flap.

3. Treat the flap as in Bryant's operation and a few days later excise the tumor. Replace the flap and close the wound with sutures. The object of this method is of course to avoid making any visible scar.

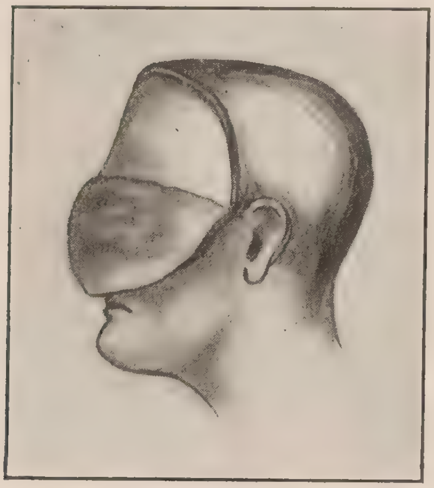

Fig. 4.

Clairmont reports from v. Eiselsberg's clinic ("Archiv. für klin. Chir.," lxxxv, 549) an operation which combined the principles of Bryant's operation and excision. Following Krause, the operation was completed in two sittings. Figs. 5 and 6 show the extent of the disease. A skiagram showed that the middle meningeal arteries were much enlarged. The occipital limits of the tumor were clearly defined; elsewhere it was not well delimited. The use of temporary hemostasis by an elastic band was impossible. Preliminary ligation would have called for the tying of both occipital arteries, the frontal artery (the size of the little finger),

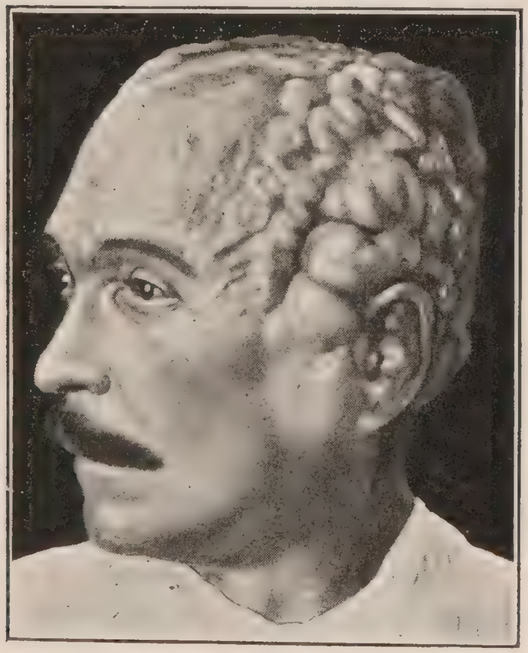

Fig. 5.—(*Clairmont.*)

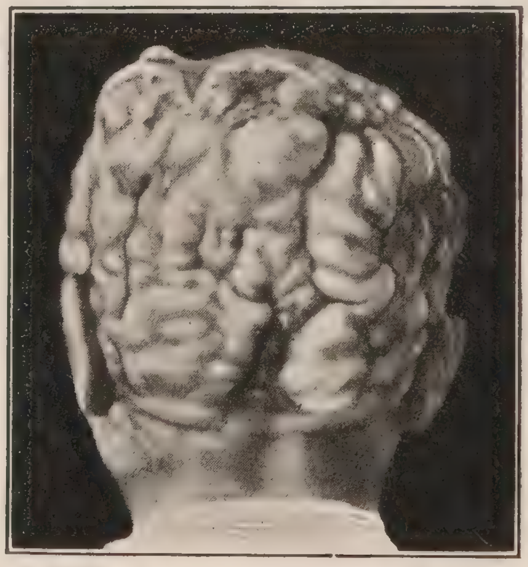

Fig. 6.—(*Clairmont.*)

and both external carotids near their origin, which might cause danger of embolism. Communicating vessels between the scalp and the inside of the skull were so numerous as to make the gain from preliminary ligations very doubtful. The operation performed may be taken as a guide for the treatment of extremely extensive cirsoid aneurism of the scalp.

Place the patient almost in a sitting posture. Anæsthetize.

Step 1.—Make an incision through the skin and epicranial aponeurosis skirting the growth anteriorly and laterally. Make the cut inch by inch, using compression on each side of the cut against the bone until the vessels are secured by forceps and ligatures. Isolate and doubly ligate the main vessels before dividing them. The incision outlines a horseshoe-shaped flap having its base at the occiput.

Step 2.—Reflect the flap from the cranium. This step requires the use of many hemostats and ligatures because of the free anastomosis with the deep vessels.

Step 3.—As in Bryant's operation, place gauze between the flap and the bone. Replace the flap over the gauze. Apply dressings and bandage.

Step 4.—After three or four days remove the dressings and excise the tumor from the under-surface of the flap. Thrombosis of the vessels in the tumor, and loosening of the surrounding connective tissue due to œdema, make the incision of the growth easier than it would have been at the first sitting.

Step 5.—Replace flap. Suture. Dress the wound.

(*D*) *Excision.*—It is very easy to excise small nevi and to close the wound with sutures. When large nevi are being excised, hemorrhage during the excision may be avoided by tying an elastic constrictor tightly around the head as in trephining or by having a rubber-covered ring (ring pessary) pressed firmly against the scalp surrounding the nevus. The operation consists in excising the disease by cutting through healthy tissue, in securing hemostasis and in closing the wound either directly or by some plastic procedure.

Aneurism.—The scalp may be the site of any variety of aneurism; usually aneurism of the scalp is traumatic in origin and is least unusual in the temporal region.

The diagnosis presents no difficulty. Excision is usually the simplest and most satisfactory treatment.

Cirsoid aneurisms have been already described.

Sarcomata of the scalp are often secondary to neoplasms of the skull but the tumors may arise primarily from the skin and the fascia. As a result of irritation or from unknown cause, pigmented moles may become sarcomatous forming melanotic and most malignant tumors. The sarcomata of the fascia form lobulated tumors which give rise to visceral metastases though in a less degree than do those arising from moles.

The treatment of sarcomata is excision but generally this is impossible as the disease has progressed too far before being observed.

Endotheliomata.—Hertzler writes, "These tumors occur as slow-growing, papillary, nodular, or ulcerated masses. When small they may be slightly constricted at the base and covered with epidermis somewhat thinner than normal. As they increase in size they tend to become nodular, and when they have attained the size of a split walnut they usually ulcerate. They tend to heal, only to break down again. As the tumor increases in size the ulcerative process becomes more general until the entire surface is affected. The growth acquires an irregular granular base and an elevated, undulating, slightly constricted border. The color is redder than the surrounding skin and is mottled with dark blue patches. The normal skin forms a wall about the base of the tumor and terminates at the edge of the ulcer in a thin, sharply defined margin of epidermis resembling very much the division of normal skin from the vascular area in a spina bifida.

"The tumors are slow of growth, and usually years elapse before the ulcerative stage is reached. Secondary nodules occasionally form in the region of the primary tumor, but there is little tendency to the formation of metastases. However, endotheliomas have been known to undergo sudden exacerbations in growth, accompanied by rapid invasion of the surrounding tissue and the formation of metastases. Tumors identical with these in external form and clinical course are sometimes formed of cystic epithelial spaces. Others, again, approach a sarcomatous structure.

"*Diagnosis.*—Their slow growth and their ulcerated, thinned epidermal covering are usually sufficient to distinguish them. The ulceration lacks the dirty incrustation of epithelioma, and the firm constricted base differs markedly from carcinoma, which is more fungoid, dense, and fades gradually into the surrounding tissue. Tuberculous processes are less elevated and the outlines are less regular. Syphilis and sarcoma are more rapid processes. On cross-section the structure resembles carcinoma very closely, and careful microscopic study is sometimes required to differentiate them. Their clinical features furnish a safer guide to diagnosis than does the gross inspection of the cut surface. This latter point should be remembered, for no doubt many of these tumors are classed as carcinoma.

"*Treatment.*—Simple excision results in a cure. If sufficient tissue is not removed local recurrence may take place, but persistence in the removal of the local recurrences will result in a permanent cure. When the period of rapid growth has been reached the prognosis is much less favorable, and even wide excision is usually followed by rapid recurrence and metastases."

Epitheliomata are not common on the scalp. They may arise from warts or ulcerated sebaceous cysts when they tend to give rise to fungus-like masses or they may assume a flat ulcerating type of slow growth and may exist for a long time without metastasis. Epitheliomata of the scalp tend to grow into the bone and even through it.

Treatment consists in thorough excision, when possible accompanied by the excision of the lymph nodes of the territory into which the affected portion of the scalp drains. If excision is impossible, exposure to X-rays may be tried.

SECTION III

TRAUMATA OF THE SKULL AND CONTENTS

By

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ANATOMY AND MECHANICS OF INJURIES TO THE SKULL AND ITS CONTENTS

The injuries resulting from the effects of violence applied to the skull vary considerably in different cases, and to some extent these variations are brought about by the anatomical peculiarities of the skull itself. First, its shape, spheroidal, gives the skull a high degree of elasticity even in the completely ossified box of the adult; while in the young the absence of synostosis adds further to the elasticity. The vault of the skull is probably stronger than the base, in part because of its dome-like shape, but also because in the greater part of its extent its structure, two tables, inner and outer, of compact bone separated by a layer of cancellous tissue, the diploë, affords a greater degree of elasticity than that of the base where cancellous tissue is practically absent save in the dorsum ephippii. The bones entering into the formation of the base of the skull are, further, perforated by numerous foramina of varying sizes; and several are hollowed out to form special cavities such as the tympanum, Eustachian tube, carotid canal and sphenoidal cells.

Elasticity plays a much greater part in the production of fractures of the skull than it does in the case of the other bones of the body. We are specially indebted to Messerer for his careful observations regarding the elasticity of the skull. He found that skulls were more resistant to pressure in the sagittal than in the transverse axis and were more resistant in the transverse than in the vertical axis. The longer a skull is in its sagittal axis the stronger it is in that direction and the less resistant in its transverse axis.

A fracture of the skull results whenever, as the consequence of the application of violence, the elasticity of the bone is overcome; and

the type of fracture which results depends upon the elasticity of the individual skull involved and the directness or diffuseness with which the violence acts. The violence may be applied in one of several ways; thus it may be in the form of (1) diffused violence which is either sudden or gradual in its action; (2) localized violence which is suddenly applied; (3) it may be the result of the action of some sharp weapon; or (4) it may be by means of firearms.

Fractures produced by diffused violence constitute the greater number of cases met with in civil practice.

The manner in which these fractures are brought about has been correctly explained by the work of Messerer, Hermann and Wahl.

Occasionally in actual practice a person's skull is caught between two wagons or between a moving wagon and a wall; the two points at which the skull is compressed may be looked on as two poles and between these there may be considered to be a series of meridian lines passing at right angles to the "equator" of the skull and the series of equatorial circles parallel to it. Compression at the two poles will shorten the diameter of the skull between them and at the same time expand the circle of the equator and the circles parallel to it; *i.e.*, it will cause a stretching of the osseous tissue to take place along these circles which will continue until the cohesion of the osseous tissue is overcome and then a tear will result at right angles, more or less, to the equatorial circles and parallel, more or less, with one, the weakest, of the longitudinal meridians. It is a "bursting" action, and (provided the violence ceases at the moment of its production) always results in a fissure of the skull being produced; the skull bursts outward, and the fracture gapes at the moment of its production, and as a result of this, in the case of open fractures, hairs are quite frequently caught between the lips of the fracture; or, in the case of basal fractures of the anterior fossa, the fat of the orbital cavity gets in between the two margins of the fracture.

When violence is applied bilaterally the skull fractures through the base in the first instance, and fissures may be limited to that region or may extend so as to involve the sides or even the vault.

Whenever they are produced, bursting fractures lie parallel to the axis of the force: if compression takes place in the antero-posterior direction, a fracture running in the antero-posterior direction is produced; if the compression be transverse or oblique, a fracture running in the corresponding direction results.

In practice fractures occur more usually from the effects of violence

applied to one side of the skull, and when the violence is diffuse, bursting fractures are again produced, though they are often not so extensive as when bilateral compression has taken place. The fracture too, in this case, begins usually at that area of the bone which bears the brunt of the injury and from that point may spread to the base, and a fracture completely dividing the skull into two lateral portions or into an anterior and a posterior portion may result. But fractures so caused do not invariably run into the base; they sometimes run an antero-posterior course along the side of the skull, and, in what are certainly rare instances, the fracture may run completely around the skull, encircling it and separating the calvarium from the remainder of the bone, the "pot-lid" fracture.

After unilateral compression it is not uncommon to find that several fissures begin at the point assaulted, and radiate off from this spot in the lines of the longitudinal meridians of this "pole."

A skull may be, and often is, assaulted in various axes, one after another, and in each of these a fracture may result, each in the axis of the pressure that caused it, though they are not necessarily parallel to one another; while on the other hand two, or more, quite separate fissures may be met with, caused by a compressing agent having a sufficiently large surface acting on one side of the skull, in which case the fissures are practically parallel to one another.

Fractures of the base occur with more certainty the nearer the area of the skull assaulted is to the base. Aran's law, that a fracture arrived at the base by the shortest route, that is, "followed the course of the shortest radius," applies to a certain number of cases; but it is quite certain that a large number of fractures begin in the base of the skull at a distance from the site of the impact of the violence.

If the violence which causes a bursting fracture continues to act after the latter has developed, the first effect will be to cause a wider gaping of the fracture's margins, but the elasticity of the skull as a whole having been overcome, the effect of the violence is now more localized and a second fracture is caused which runs more or less at right angles to the axis of pressure, *i.e.*, in an equatorial circle and not in one of the longitudinal meridians. This fracture is brought about by "*bending*" *action;* and the line of fracture may approximate to or be an actual circle. It often happens that one bending fracture is produced after another, the result being a series of concentric ring fractures. One variety of fracture by bending action is very characteristic and is seen in the neighborhood of the foramen magnum; it is often

spoken of as the "ring fracture." It is the result of a fall from a height, or a dive into shallow water, etc., when the head of a person impinges on the ground and, with the momentum of the trunk following on, the atlas is driven violently against the occipital condyles and fractures the occipital bone. The line of this fracture commences on either side of the foramen magnum and often runs on into the jugular foramen where it may end, but the fracture may continue on into the middle fossa, and frequently the two fissures unite in the sella turcica.

This fracture may not be a complete "ring;" it is sometimes limited to one side of the skull only, and this in all probability depends upon the position of the head in relation to the vertebræ at the moment of impact, *i.e.*, whether it is reflexed forward, backward, or laterally at the time.

Bending fractures are, however, caused independently of bursting fractures and are always the result of localized violence; the smaller the surface of the wounding object the more absolutely localized is the resulting fracture. The type of this fracture is what is often spoken of as a "Pond" or "Gutter" fracture. It is quite frequent in these fractures to find that the internal table is more extensively broken than the external; and further, the two tables of the skull in the fractured area are frequently separated from one another horizontally along the diploë. Fragments of the internal table in this type of fracture occasionally get displaced beneath the surrounding intact bone and are often responsible for lacerations of the dura mater and injuries to the brain or its vessels.

When violence acts sharply and suddenly upon the unsupported, freely swinging head an area of bone is depressed toward the interior of the skull quite frequently without the remainder of the skull, or its contents, suffering in any way whatever; the individual may not even fall and, when he does, he is often not unconscious. On the other hand, when the violence is more diffused, if the wounding object have a broad surface, a patient is generally knocked over, and he may or may not be rendered unconscious. If a fracture is produced in the latter case it is generally of the bursting type; whereas in the former case it is a bending fracture.

If the violence has its effects more directly at the base of the skull, instead of the vault (as in the knockout blow on the mandible in a prize fight), the patient falls unconscious at once.

The effect upon a skull is the more localized the smaller the surface of the wounding object. Messerer showed that with a bolt 2 cm. in

diameter he could produce a clean-cut opening in the skull without radiating fissures. With a bolt 4 cm. in diameter he produced holes with fissures of the surrounding bone, with a broad plate he only caused fissures; and clinical experience bears this out.

Occasionally a fracture involving the internal table alone is caused; it is the result of a tearing of the bone at the summit of the depression caused by the impact, and always the margins of the fracture are depressed toward the brain. Such fractures are of importance for they cause few signs at the time, but may be a source of irritation of the brain later on, leading to epilepsy or mental disturbance.

Fractures of the Skull in Infants.—Although fractures do undoubtedly occur during intrauterine life, due to violence applied to the fœtal skull through the maternal structures, they are distinctly rare.

During labor, however, it is not uncommon to find that fractures either complete or incomplete are brought about. The incomplete fractures are either indentations or partial tears of bone, the frontal or parietal bones being most often affected; and they result from pressure of the forceps or of the sacral promontory. Complete fissures, usually involving one of the parietal bones, also occur during labor, or occasionally a diastasis of one of the sutures is brought about. After birth, partial or greenstick fractures are met with now and then in young children, but only, as a rule, before the time at which the diploë develops and separates the two layers of the bones.

Fracture by Contre-coup.—It occasionally happens that two or more isolated and distinctly separate fractures are found in a skull as the result of the same assault. In such a case the second fracture may be an indirect fracture, for if the violence has been diffuse, a portion of the skull (especially at the base) which is thin and brittle, like the roof of the orbit, may break in consequence of the distorting strains to which it is subjected.

However, in some cases true isolated fractures are met with which are due to violence directly applied at two opposed points of the skull; thus, a person receives a blow over the front of the skull which fractures the bone at that region and fells him; in falling the occiput may come into contact with hard ground, a flagstone, etc., and a second local fracture may be produced in that region from direct violence.

Fractures Caused by Sharp Weapons.—These injuries are in reality fractures produced by bending action and caused by objects which are pointed or have only a small surface, *e.g.*, daggers, knives, pencils, pens, pitch-forks, umbrella ribs, etc. They are met with both at the vault

and at the base. When a very fine instrument, such as a bodkin, the rib of an umbrella, etc., causes the injury it is rather of the nature of a punctured wound of bone than a fracture; and while weapons having a larger superficial area may still produce "punctures" of the bone, the margins of the opening generally show fine radiating fissures running off in various directions, though often these fissures are so small that they cannot be made out until the skull is macerated. Injuries of this class are of the greatest importance, for the instrument causing them is usually carried into the membranes or the substance of the brain itself, thereby directly implanting infection in the interior of the cranial cavity. The instrument is occasionally broken and a portion of it, *e.g.*, the blade of a dagger, left behind in the wound. In the case of fractures of this type involving the base of the skull, and caused by pencils, penholders, walking sticks, etc., being forced through the nasal or orbital cavities, the eye, the optic nerve, or some of the great vessels at the base of the skull, the cavernous sinus or the internal carotid artery, etc., may be injured. The diagnosis of a fracture of this nature from mere clinical examination of the part is not always easy, as the weapon, or the external part of it, is frequently removed before the patient is brought for medical assistance.

Fractures are sometimes brought about through the agency of weapons having a broad and wedge-shaped edge, such as a sword or hatchet, when either complete or incomplete wounds of the skull are caused. If a direct blow is given to the skull by such a weapon and penetration occurs, it generally happens that extensive splintering of the internal table is brought about along with injury to the brain or its membranes. But if the blow be a tangential or glancing one the effects may be various: (1) a slice of the vault of the skull with the adherent scalp may be cut clear away from its surroundings, (2) a slice of bone may be elevated above the level of the surrounding bone though not necessarily separated from it, (3) the bone slice may be turned up free from its bone attachments but with a scalp pedicle holding it to the remainder of the scalp, very much like the osteoplastic skull-flap of the surgeon. In such cases fine fissures can generally be shown to exist in the margin of the surrounding skull radiating, meridian-wise, from the area which has been assaulted. The brain and membranes may or may not be injured at the same time; the dural sinuses are said to be more often involved than the arteries in this type of fracture.

The Types of Fracture of the Skull.—These may, in the first place, be described as incomplete and complete fractures.

An incomplete fracture may involve the external table only or the internal table. Those of the external table are met with at the frontal sinuses, the mastoid cells, or sometimes at the occipital protuberance where there is an excess of the diploë. They are seen as fissures or as comminuted fractures with or without depression of the fragments, or, in rare instances, with elevation. Very rarely an incomplete fracture is seen involving the internal table alone, nearly always the result of extremely localized violence of considerable intensity.

Complete fractures may be (1) *fissures*, which occur in great variety. They may be single or branched or multiple; they are at one time straight lines, at another they run a curved or zigzag course. They may cut across one of the sutures of the skull; at another time follow the line of a suture, causing a diastasis; or, again, after producing diastasis for a certain distance, a fissure may diverge from the suture and run off at an angle from it. The direction followed is determined, in any individual case, by the nature and direction of the violence, the thickness of the skull, the presence or absence of foramina, sutures, etc., and the "graining" of the bones at the area involved.

They are caused by either a bending or a bursting force.

2. *Comminuted fractures* are often extremely localized, in which case there may be considerable depression of the bone, the internal table being always more extensively fractured than the external. This type of fracture is the result of a bending action.

3. *Punctured fractures* are bending fractures produced by small, and especially by pointed, objects. The smaller the object the cleaner is the perforation produced; the internal table is always fractured more extensively than is the external, and in some instances a portion of the bone is driven into the cavity of the cranium—"fractures with loss of substance" or "hole-fractures." They are invariably open injuries, only one case of a closed punctured fracture, *i.e.*, without a wound of the soft parts over it, being known to the writer as having been recorded.

4. *Elevated fractures* have been sufficiently referred to in discussing the mechanism of the production of fractures. Any of the above-noted types of fractures may be "closed" or "open" ("simple" or "compound"), a distinction of the greatest importance, as sepsis, with the possible involvement of the intracranial structures, is the most serious complication that can occur in these cases.

Fractures of the base of the skull are as a rule either of the fissured or punctured type. They are very frequently open fractures, the mucous membrane of the ethmoidal cells being so often lacerated in

fractures of the anterior fossa, or that of the roof of the nasopharynx in the case of a middle fossa fracture. The latter may also be rendered an "open" fracture if the tympanic cavity should be implicated (1) in consequence of its communication with the pharynx or (2) by a rupture of the tympanic membrane.

THE SIGNS OF FRACTURES OF THE SKULL

A. **Fractures of the Vault.**—The diagnosis of these injuries is in some cases the easiest possible, and in others as difficult as any.

An open depressed fracture of the vault is obvious at once in most cases; fissures show up at the bottom of a scalp wound as red lines which persist in the exposed bone in spite of wiping, as the blood lies between the margins of the crack. Where a fracture is suspected in the presence of a wound of the scalp, the use of a probe is not only dangerous but it is uncertain; the only instruments to employ for the examination are the eyes and an aseptic finger. If a wound be too small to permit inspection of the bone, and if the latter can be examined only by digital palpation, a natural groove in the bone, a suture, or even a slit in the pericranium may be mistaken for a fracture. In such a case, if doubt still remains, the wound ought to be enlarged sufficiently to permit accurate palpation and ocular inspection.

Where no wound exists a fissure can at times be palpated through the scalp; this depends upon the degree of gaping of the margins and the degree of swelling of the scalp. Depressions of the skull bones are generally readily recognized; the movement communicated by the examining hand to a loose fragment of bone can at times be made out, and in rare instances bony crepitus can be felt in cases where comminution exists.

One must not mistake the irregularities of sutures or the presence of Wormian bones for fractures.

Hematomata of the scalp often cause difficulty in one's decision as to the presence of a fracture. The hematoma itself frequently brings about a state of things closely resembling a depressed fracture, presenting a firm zone at its circumference which bounds a central depression. Steady pressure over the firmer peripheral zone of the hematoma, which is frequently elevated above the level of the surrounding scalp, permits the finger to sink through the swelling until it reaches bone. The resemblance to a fracture is at times so close that a decision can be arrived at only by an incision through the tissues to the bone and

a direct examination of that structure. Examination of skulls with hematomata by means of the X-rays has shown that in many cases, especially in childhood, a fissure exists below the effused blood.

The writer has found great help in the systematic percussion of the heads of patients who have sustained injury, and has come to look upon it as a valuable aid in the diagnosis of fractures of the vault. The results are more certain when the head has been shaved, though the change in the note is quite often distinctly recognizable prior to the shaving. If the patient is conscious he should sit up and keep the mouth closed; if sitting up be impossible, the head should be supported by one hand beneath the occiput while a finger of the other hand is free to percuss over corresponding areas of the two sides of the skull. In the region of a fracture the note obtained is lowered in pitch and frequently has a cracked-pot sound which is always most pronounced in cases of T-, L- or V-shaped fissures, and is best marked when the percussing finger strikes the angular portion of bone between the limbs of the "T" "L" or "V." The note obtained is blurred in cases where there is hemorrhage into the subaponeurotic space, or where there is edema of the scalp tissues. Further, in conscious patients with a fissure of the skull vault, percussion in the immediate neighborhood of the line of fracture often produces pain, always along the same line, and during many days after the infliction of the injury.

Another sign of some importance is the escape of blood from the interior of the skull beneath the scalp and the formation of a diffuse hematoma; this is seen most characteristically in cases of fissures crossing the middle meningeal artery or one of the venous sinuses of the dura. The hematoma may reach considerable dimensions and produce great tension of the overlying parts; in rare cases it may pulsate.

Open fractures of the vault are generally evident at once. Cerebro-spinal fluid may escape in some instances, and in other and more severe cases brain matter is found in both closed and open fractures.

B. **Fractures of the Base of the Skull.**—In these case the diagnosis is aided by the escape of (1) blood, (2) cerebro-spinal fluid, (3) brain tissue, (4) air or (5) by the involvement of various cranial nerves.

I. (*a*) *Bleeding into the tissues* occurs at the orbits or at the mastoid region. At the orbit, blood appears beneath the conjunctiva at either the external or internal canthus and spreads forward over the eye; it is in the majority of cases due to a fracture of the anterior fossa of the skull. The eye-lids show marked discoloration, and the lower lid in

particular becomes baggy from œdema. In some cases the amount of blood extravasated into the orbit is so great as to produce exophthalmos. Bruising at the tip of one mastoid process and along the anterior margin of the sternomastoid muscle occurring three or four days after injury to the head is usually the result of a fracture of the posterior fossa. When bruising occurs at both mastoid processes it is an indication of a complete transverse fracture of the base of the skull.

(*b*) *The escape of blood from the cavities* in proximity to the brain, *e.g.*, the nose, mouth, or ears, takes place in some instances. Hemorrhage from the nasal cavities taken in conjunction with other symptoms is at times of value as a diagnostic aid, though taken alone it is not of much help, as the nose is so liable to direct injury. In fracture of the skull nasal hemorrhage is due to fracture of the ethmoid bone and laceration of the mucous membrane lining the ethmoidal cells, and perhaps to tearing of the ethmoidal arteries; it is not great in amount as a rule. In some cases it may be most profuse and is then due to tearing of one of the large vessels inside the skull, *e.g.*, the superior longitudinal on the cavernous sinus.

Bleeding from the mouth may occur in fractures of all three fossæ of the skull. From the anterior fossa blood runs back to the nasopharynx. From the middle fossa it may escape into the nasopharynx from one or both of the sphenoidal cells; from the posterior fossa with involvement of the tympanum the blood may pass down by the Eustachian tube. By whichever route it reaches the nasopharynx, the blood at times escapes from the mouth almost at once; at other times it is swallowed to be vomited later on. As a rule the amount lost by this route is small, but it may be so great (as where a carotid artery is torn in a middle fossa fracture) as to lead rapidly to death from hemorrhage.

The escape of blood from the auditory meatus is fairly frequent in head injuries, but it is not always the result of a fracture involving the cranial fossa, though of course it frequently is. Bleeding may occur from rupture of the tympanic membrane, from fractures of the osseous meatus with or without fracture of the mastoid process, or from partial separation of the auricle from the bone. Bleeding, the result of fractures involving either the middle or posterior fossæ, occurs from the external auditory meatus in a certain number of cases; it is generally not profuse, but lasts many days, is venous in character in the majority of cases, and is probably due to injuries of the superior petrosal sinus or the mastoid cells. When it is arterial, which is rare, it occurs from

branches of the meningeal artery. Hemorrhage into the tympanic cavity is now and then seen at a post-mortem examination where none has escaped from the meatus owing to the membrana tympani remaining intact; in such cases the membrane has a bluish appearance during life. When the latter is ruptured it is often possible to see the tear through a speculum.

Aural bleeding is a sign of some importance in skull fractures. Crandon and Wilson found that in cases of hemorrhage from one ear there was a mortality of 39 per cent., while when it occurred from both ears the mortality was 66 per cent.

II. *The escape of cerebro-spinal fluid* from the nose or ear is met with, but not often on the whole. From the nose it is decidedly rare.

From the auditory meatus it usually begins within 24 hours from the time of the accident. It is tinged with blood at first, though often it comes quite clear; and it is often discharged quickly and freely, soaking dressings time after time, and may continue for days; in one case the writer saw it continue for 12 days, pints of it being discharged during that period. Forced expiratory efforts generally cause a rapid flow during their performance.

III. *Brain tissue escapes from the nose or ears* in a few rare cases, and constitutes the most certain evidence there can be of a fracture of the base with rupture of the membranes of the brain. It is rare from the ear, and still more so from the nose; its occurrence signifies considerable disintegration of the brain with dislocation of bone fragments.

IV. *Emphysema of the subcutaneous tissues* is a rare sign of fracture; it occurs only after fractures involving either the frontal sinuses on the mastoid cells, and in both situations after a patient has made forced expiratory efforts. The emphysema, when it occurs, is strictly limited to the immediate neighborhood of the injured bone.

V. *Injuries to the cranial nerves* occur and afford valuable evidence of fractures of the base. The injury may be primary—that is, the nerve or nerves are torn opposite the line of fracture at the moment of its production or are torn out from their origins at the surface of the brain, owing to the distortion of the skull which results from the injury; or, on the other hand, the nerves are involved secondarily by the pressure of effused products, blood or inflammatory exudations.

The first pair of nerves is frequently involved, sometimes directly by a fracture passing through the cribriform plate, but more often probably as the result of force applied to the skull at a distance, producing laceration of the orbital surface of the frontal lobes and, along with that,

destruction of one or both of the olfactory bulbs and tracts. With loss of smell there is generally a varying degree of loss of taste.

The optic nerves are injured either directly or indirectly. In the former case the nerve or optic tract may be actually divided; in the latter it is generally compressed by blood or by displaced bone (possibly this is due to fracture of the anterior clinoid process and subsequent displacement of the fragment). The effect may be a total or partial loss of vision which results immediately, or develops only later on in the course of the case; though, as many of the patients are unconscious for considerable periods of time after the accident, evidence of the injury to the nerve may not be forthcoming for some days.

Injury to the optic tract is of course followed by hemianopia.

Partial loss of vision may result from retinal hemorrhages with subsequent retinal changes, or from separation of the retina.

The third nerve may be involved directly in cases of direct fractures of the orbital roof, by the penetrating object which causes the fracture, or by fractures of the sphenoid bone; but more often its function is interfered with by blood extravasations, or by infective processes at the base of the brain. Like the other nerves in relation to the cavernous sinus it is liable to be involved in cases of pulsating exophthalmos, or of thrombosis of the sinus.

Symptoms.—Ptosis; external strabismus; mydriasis; loss of accommodation; slight exophthalmos.

The fourth nerve is only rarely affected without some of the other nerves of the orbit being involved.

Symptom.—Defective movement of the eye downward and outward due to paralysis of the superior oblique.

The fifth nerve also is generally affected in association with some other cranial nerves. The second and third divisions are very rarely interfered with, permanently at any rate. The first division is occasionally affected, leading to anesthesia of the areas supplied by it, and, more important still, as the result of the anesthesia of cornea and conjunctiva, to sloughing or ulceration of the cornea. The writer has several times seen herpetic eruptions over parts supplied by one or other of the branches of the fifth nerve, although there was no evidence of paralysis, and believes that these eruptions were evidence of disturbance of the nerve fibers by hemorrhage.

The sixth nerve is not often affected in head injuries, in spite of its close relation to the apex of the petrous bone and to the dorsum ephippii, but is sometimes involved by exudations at the base of the skull.

The seventh or facial nerve is probably more frequently involved than any of the other cranial nerves; the effect may be partial or complete, transient or permanent. The cases of permanent and complete paralysis are usually associated with complete deafness and are due to laceration of the nerve in the Fallopian aqueduct; while the cases of partial paralysis are most frequently the result of exudation compression, and generally develop a day or two after the accident. The muscles supplied by the seventh nerve are at times paralyzed owing to the cortical center being injured or compressed; in these cases the muscles of the upper part of the face are often spared. With complete facial paralysis there may be ulceration of the cornea, epiphora, and disturbance of mastication.

The eighth nerve is rarely involved alone, but may be torn at the porus acusticus without the seventh nerve's being affected, when permanent and complete deafness on the side of the tear is the result. Permanent deafness may also result from injuries to the labyrinth. Blood in the tympanum, or rupture of the membrane with injury to the ossicles, will cause some interference with hearing; and, even though it is not absolute, it is often serious enough to the patient.

The ninth, tenth, eleventh and twelfth nerves rarely manifest evidence of their involvement, and only a few cases are on record of direct injuries to any of them; but secondary compression which is recovered from, is not altogether rare. One frequently sees patients with marked difficulty in swallowing, after injuries to the head, where there is reason to believe there is blood extravasted near these nerves.

The prognosis in skull fractures depends chiefly upon the intracranial complications that may be associated with them, *i.e.*, lacerations of blood-vessels, or the spread of infection.

If infection can be prevented, and if the brain is uninjured, most cases recover. The first twenty-four hours is the most critical period.

Open fractures are necessarily more serious than closed ones; which fact explains in part why fractures of the base are generally speaking more serious than vault fractures. Basal fractures as a rule are the result of greater violence, more diffused at any rate, than vault fractures, and are more often associated with contusions and lacerations of the brain, and are, therefore, more often followed by signs of compression of the brain.

The union of fractures of the skull takes place readily as a rule. Callus tends to form more on the internal aspect of the skull than on the external—from the dura mater rather than from the pericranium.

In consequence of the internal table's fracturing more widely than the external and its fragments being often displaced, osteophytic developments take place which in certain instances lead to irritation of the brain beneath, and this may have serious consequences for the patient. Depressed fractures of the vault are specially prone to this development of osteophytes.

Punctured fractures of the skull are of the greatest importance, for the internal table is always more extensively fractured than the external, and some bone fragments are often carried into the cranial cavity. The brain and membranes are not only very frequently directly injured, but may have infective material carried directly into their substances, for these are practically open injuries.

With elevated fractures of the vault the prognosis is mainly dependent upon the presence or absence of injury to the brain. The bone flap, as a rule, unites readily when brought into its correct position.

The Treatment of Fractures of the Skull.—Patients suffering from these injuries require to be kept quiet and warm. Shock effects must be combated.

Closed, or subcutaneous fissures of the vault may be left without operation until signs calling for trephining arise. The writer is strongly of opinion that all cases of depressed fracture, whether closed or open, require operation for the purpose of readjusting the fragments to their proper level and plane.

In the case of open fractures of the vault too much care cannot be given to the thorough cleansing of the wound. The margins, and frequently the whole surface, of the wound of the scalp may be excised; all dirt particles must be scrupulously removed; bone ingrained with dirt requires to be chiselled off; it is frequently necessary to go down to the level of the diploë to get rid of all the infected bone; and in the case of open fissures of the vault the whole line of the fissure exposed should be chiselled out, often down to the dura mater level; for between the closed margins of these fissures; hairs and dirt of all kinds will at times be found concealed.

Loose fragments of bone should, as far as possible, be cleansed, placed in warm saline solution till required, and replaced over the dura when the toilet of the wound is complete. Where the asepsis is all right these fragments of bone heal in, but to secure this they require to be covered with the soft parts. In the case of closed fractures no difficulty is experienced in this respect, but in open fractures it may not be easy to bring the margins of the wound together, and then incisions

of relaxation may be required, or a flap may be cut from the scalp to cover the bone lesion.

Where, on account of the presence of sepsis, reimplantation of the trephine discs or bone fragments in comminuted fractures cannot be made, it will sometimes be desirable to endeavor to give protection to the brain and its membranes by filling in the gap in the skull. Various procedures have been proposed to this end. Bone, metal plates, rubber tissue, celluloid plates, etc., etc., have all been employed. Of these, celluloid appears to the writer to be the material most suitable. The osteoplastic method of König-Müller has much to recommend it when the gap is so placed that the bone in the neighborhood can be satisfactorily cut, *i.e.*, where there is a diploë present. If left unprotected, such gaps in the skull may be filled in by bone produced by the dura mater, but this is an extremely rare occurrence, and one that cannot be relied upon.

All punctured fractures require immediate trephining for the reasons already indicated.

As to fractures of the base we are unfortunately in a much worse position as regards treatment.[1] A large proportion of these patients have open fractures communicating with cavities which are always septic, and where little can be done to make them less so. Urotropin should be administered in all these cases, and especially when there is an escape of cerebro-spinal fluid. The less done in the way of attempting to cleanse the nose and auditory meatus in these cases, the better, probably.

GUNSHOT INJURIES OF THE SKULL AND BRAIN

The effects upon the skull caused by the impact and penetration of a bullet are determined in the main by the shape, caliber and momentum of the projectile, and the distance that it traverses the brain.

The modern cased bullet of small caliber loses its power of perforating the entire skull at a range of about one and a half miles.

At a range of about 2000 yards the skull is perforated, the wound of entrance presenting a greater degree of injury to the internal table, and the exit wound a greater amount of injury to the external table.

Fired at a short range complete disruption of the scalp, skull and its contents is produced, the fragments being scattered in all directions; if

[1] It is sometimes wise to open the skull as if for hemorrhage from the middle meningeal artery or at a lower level, and to remove enough bone so that a rubber tissue drain may be placed on the floor of the skull as a prophylactic measure against infection or the collection of effusions at the base of the brain. (*Editor.*)

the bone fragments, however, be collected and put together, the skull will present a wound of entrance and of exit demonstrating that the skull and brain are first of all perforated by the bullet and that the disruption takes place after that. In experiments the skull is never disrupted if the brain is first removed from its interior. The disruptive effect is, therefore, caused by the bullet's acting upon the brain; the action is hydrodynamic.

Between these two results, the complete disruption and the two simple "hole fractures," every variation may be met with depending upon the range of the shot.

At 50 yards the skull is shattered; but the scalp is capable of holding the fragments of bone together although it presents wide entrance and exit wounds.

At 100 yards the wounds of entrance and exit present a series of fissures radiating meridianwise from them (bursting-fractures), joined by fissures (bending-fractures) circling the hole-fracture in the center.

At about 800 yards the bending-fractures disappear and only the bursting-fractures persist.

At long ranges the injury to the brain is restricted to the formation of a tunnel through its substance with condensation of the tissue in the walls of the canal. At shorter distances, but where disruption still does not follow, the dura mater and the brain show lacerations and the brain has hemorrhages scattered throughout its substance while the ventricles contain blood or blood-stained fluid. If a bullet meets the skull at a tangent an impression fracture (gutter fracture) may result, the external table being sometimes carried away leaving the internal table depressed and splintered, generally over a greater area than that of the external, and very frequently spicules are driven into the substance of the brain. In other cases a portion of the skull wall may be shot away, fissures, radiating off into the surrounding bone, being produced at the same time. In other instances a fracture of the internal table alone may be produced.

Pistol shots cause wounds with radiating (bursting) and concentric (bending) fissures around the entrance wound, and the wound of exit as well, if there be one; but commonly the bullet lodges in the brain and does not perforate the skull.

Bullet fractures of the base of the skull are of great importance on account of their proximity to the medullary region, and because of the injury to large blood-vessels within the skull that so often happens in these cases. In those cases which are not immediately fatal, the effect

of the bullet wound is to cause, rapidly, symptoms of compression of the brain from hemorrhage. There may be localized irritative or paralytic signs associated, which are often due to the direct injury to definite areas of the brain during the transit of the bullet.

Prognosis depends upon the caliber and momentum of the bullet and the region of the brain involved. It is markedly influenced by the presence of sepsis.

Treatment.—One's object should be to (1) arrest hemorrhage, (2) afford free drainage, (3) maintain asepsis, (4) inflict as little injury upon the brain as possible in securing these results. Where there is splintering of bone and fragments are driven into the brain they should be removed; depressed bone must be elevated; and, if necessary, the original wound may be enlarged to relieve tension and permit drainage of blood, blood-clot and bruised brain tissue. Where comminution of bone does not exist, primary trephining is not generally required unless there be severe compression or Jacksonian convulsions. Attempts to remove the bullet ought not to be made in the first instance as it may become encapsuled and give no trouble at all. When a bullet does give rise to trouble its removal may be attempted after it has been localized by X-ray examination carried out immediately before the operation in at least two diameters of the skull. The after-effects of bullet wounds of the brain are quite frequently due to scarring of the brain rather than to the actual presence of the bullet so that the successful extraction of the latter may result in little benefit for the patient.

Concussion of the Brain ("*Cerebral Commotion*").—This state, so often seen after head injuries, is the consequence of the application of sudden and diffused violence to the skull. It is remarkable that in a very large number of cases of injuries to the skull, often severe in themselves but caused by violence localized to one area, all signs of concussion are absent; and one frequently sees cases of local depressed fractures of the skull where the patient has not manifested any evidence of concussion whatever.

The accidents which most certainly produce concussion symptoms are those by which the skull and brain are suddenly knocked into motion, *e.g.*, by a blow upon the freely movable, unsupported head; or where, as in a fall from a height, the moving head is suddenly arrested by any object of sufficient resisting power to produce a jarring of the skull and its contained brain.

The symptoms recognized as those of concussion are the result of a

general commotion of the brain substance by the vibrations set up in it in consequence of the injury.

It is extremely rare to find, at a post-mortem examination of a patient dead after a head injury, no evidence of damage to the brain; minute hemorrhages scattered throughout the brain substance are seen macroscopically in almost every case, while histologically there is very constant evidence of chromatolysis and vacuolation of the nerve cells.

But there are undoubtedly authentic records of cases of concussion where no cerebral lesions have been macroscopically obvious at post-mortem examination.

The state of "concussion of the brain" is one of "shock" and like other cases of shock is due to a sudden diminution of the vasomotor activity, with anemia of the brain as the result.

Duret and his followers have argued that as the consequence of the blow, cerebro-spinal fluid is suddenly displaced from the ventricles and forced, suddenly, into the fourth ventricle through the iter, and that stimulation of the vasomotor centers results from the damage done to the floor of the fourth ventricle which is manifested by small hemorrhages in the brain substance at this area. In the writer's experience these hemorrhages are remarkable for their absence in those cases of head injury that come to post-mortem examination.

Kocher and his followers consider the condition to be one of "acute brain-pressure" (acuter Hirn-druck), the result of the minute hemorrhages throughout the brain; but it is difficult to conceive that, in the slight and actually the clinically "typical" cases of "concussion," such hemorrhages can be present, and yet the patients recover consciousness as rapidly as they do.

Symptoms.—Extraordinary variations in the degrees of severity of concussion are met with. A patient may die from the result of concussion, though this is a rare occurrence. Another patient is merely rendered giddy by the violence, has a momentary loss of consciousness, some mental confusion, and quickly recovers: and between these two types, the slightest and the severest, every degree of concussion may be seen. The symptoms of concussion can merge into those of compression or of laceration of the brain, but they are invariably immediate in their onset; when there is anything of the nature of a "lucid interval" following the injury the symptoms that develop are due to some other state than concussion.

In typical cases a patient who is "concussed" falls to the ground unconscious, the face is pale, the eyes closed or half-open, the con-

junctival reflex is generally absent, the pupils are wide or of medium size, but are not contracted, the pulse is slow and small, respiration is shallow and not uncommonly sighing. There is general relaxation of the muscular system and very frequently both urine and fæces are voided unconsciously. The skin is moist with sweat and the general body temperature is lowered. When one shouts at the patient he may or may not be able to give monosyllabic replies.

A patient may remain unconscious for hours, certainly, perhaps for days, and still recover, but the longer he remains unconscious the less likelihood is there of the condition being one of simple concussion.

In cases of pure concussion the patients gradually recover consciousness, they frequently vomit, become restless, and complain of headache or pains throughout the body and limbs; the frequency and force of the heart-beat return, the body heat is restored and, by degrees, all the symptoms pass off.

A patient who has been "concussed" very generally has complete loss of memory for all events at the time of the injury and frequently for some time previous to it.

Treatment.—Warmth for the patient is the great desideratum. Hot drinks when he can swallow. The head may be lowered in bad cases; and a firm binder, applied round the abdomen, and bandages to the limbs may be a help. The intravenous injection of saline and artificial respiration may be necessary in some of the severe cases.

Calomel or some other purgative should be given as soon as the patient can swallow.

Every patient rendered unconscious by a blow upon the head should be kept quiet in bed for *at least* four weeks afterward, as thereby various neuroses to which these patients are liable are most completely avoided.

Compression of the brain may exist in two forms: localized and general. The former is seen in cases of middle meningeal and extradural hemorrhage, œdema, tumor, abscess or foreign body; the latter in subdural diffuse hemorrhage, and in meningitis.

As a complication of fracture of the skull compression symptoms may be brought about by (1) depressed bone, (2) effused blood, (3) œdema of the brain and membranes, (4) inflammatory exudations.

The theory most generally accepted regarding the production of compression is that the brain itself is incompressible and that symptoms are brought about only by a rise of the tension of the cerebro-spinal fluid. Normally the cerebro-spinal fluid can be displaced and escape

into the spinal canal and nerve sheaths, or into the blood-vessels. If the pressure in the veins or sinuses is raised, as happens with increase of intracranial tension, one means of exit is blocked. The other may also be blocked through translocation downward of the brain so that the isthmus through the tentorium becomes obstructed, and the cerebro-spinal fluid is prevented from escaping into the spinal canal.

Within the last few years the proposition put forward in 1890 by Adamkiewicz, that pathological increase of the tension of the cerebro-spinal fluid does *not* occur, and that the brain tissue *is* directly compressed (condensed), has been receiving attention; and the results of some experimental work carried out by several observers have been published in support of it.

That there is an increase in the tension of the cerebro-spinal fluid is certain from clinical experience. During the course of operations for compression following upon trauma the fluid often spouts like a small fountain when the dura mater is divided; and conversely after a trauma producing a localized extradural hemorrhage even of large dimensions, all symptoms of compression may remain in abeyance if the cerebro-spinal fluid can escape to the exterior through a fracture (*e.g.*, of the petrous bone), and escape through the auditory meatus. But the brain tissue itself may be compressed in cases of fracture with extra-dural hemorrhage, for it will occasionally happen that after an operation at which all clot has been removed, the patient nevertheless succumbs, and at post-mortem examination it is found that the brain is still compressed locally beneath the site of the clot.

It is probable that in the average type of compression case without an external escape of cerebro-spinal fluid, the general symptoms of compression are the result of the increase of the tension of the fluid, but that the localizing symptoms, *e.g.*, the hemiplegia following an extra-dural clot, are caused by the local pressure upon the brain tissue itself. It has been shown experimentally that while compression symptoms can be produced with a free escape of cerebro-spinal fluid, it requires much greater pressure to do so than when the fluid is confined.

As the tension of the fluid is increased it tends to cause an anæmia of the brain. When a localized compression occurs that area of the brain beneath the compressing agent (clot), or round it (abscess or tumor) has the blood expressed from its vessels and again anæmia—local this time—is produced—"Adiamorrhysis."

A considerably greater pressure is required in the cerebral supra-tentorial cavity than in the cerebellar infratentorial space to cause

symptoms; while in the region of the medulla the pressure requires only to be very little above that of the capillaries to produce fatal results.

In cases of pure compression the medullary centers are the all-important ones and their reaction to the effects of the compressing agent is remarkable. The first effect is one of irritation or stimulation. The vasomotor, the respiratory and vagus centers each are affected. The blood pressure rises, the tension of the pulse is greatly increased, the heart is slowed, and the respiratory act becomes somewhat irregular as to depth and rhythm. With the rise of blood pressure thus produced these centers again become better supplied with blood and their activity is eased off. With a further rise of intracranial tension cerebral anæmia is again produced and again results in stimulation, and once more the blood pressure rises to "force the cerebral circulation;" this cycle may occur several times, until the vasomotor center ultimately becomes exhausted and gives out, and the symptoms of compression progress.

Death takes place from paralysis of the respiratory center, the onset of which is indicated by the development of Cheyne-Stokes respiration. The heart may continue to beat for some considerable time after all respiratory efforts have come to an end.

With a circumscribed compression a localized anæmia is brought about at that area but the compression on the veins of surrounding parts of the brain is increased and venous obstruction results, to be followed by œdema of the brain and soft membranes around the anæmic zone; and, in consequence of this, centers of the brain at a distance from the actually compressed area may be involved and cause symptoms, *e g.*, epileptiform convulsions may be produced by involvement of the motor centers in this manner.

In the rapidly developing compression of the brain with which we have specially to do in traumatic cases the gray matter of the cortex is always the first to suffer; and at a time when the effect of the compressing agent is to paralyze its functions, the more automatic centers of the medulla may only evidence irritative signs.

The symptoms of compression may be divided into two types, irritative and paralytic.

The irritative symptoms manifest themselves by headache, some mental dullness, restlessness, vomiting, rapid pulse and respiration, the respiratory acts being often irregular at first. There are narrowing of the pupil, and edema of the optic discs and retina.

Progressive loss of consciousness, loss of the superficial reflexes, with

slowing of the pulse, which later on becomes full and hard, "bounding;" slowing of the respiratory movements with deeper action and often associated with stertor; dilatation of the pupils, loss of the deep reflexes; often excessive sweating, retention of urine followed by overflow, involuntary evacuation of the bowel, indicate the progressive character of the symptoms and the onset of paralytic phenomena. This is the stage of "manifest compression" with complete coma.

With increase of the intracranial tension there is further evidence of paralysis; slowing of the pulse and respiration gives way to a marked increase in frequency, the pulse becomes soft and small, the respirations occur in cycles (Cheyne-Stokes breathing) there is still further dilatation of the pupils, marked cyanosis, fall of the blood pressure, and death from paralysis of the respiratory center.

During the progress of the case there may be signs of localized pressure upon the brain, *e.g.*, paralysis of ocular muscles or a contralateral paralysis of one or both limbs, or complete hemiplegia. In some cases convulsions occur. The body temperature is often low, but in many cases is markedly elevated.

In the diagnosis from concussion the state of the pulse, respiration and optic discs are most important guides, when there is the absence of a history of a lucid interval. Compression symptoms generally require time for their development and quite frequently are superadded to those of concussion. Inequality of pupil, or a pupil which does not react to light, points to compression.

A complete examination of the patient is always necessary in suspected cases, and very particularly in cases of coma where a history of trauma is not forthcoming.

Alcoholic coma is probably the condition most often in view, and, as alcohol is so frequently responsible for the injury producing the head condition, difficulty not uncommonly arises. The pupils afford the characteristic feature; for in compression of any considerable degree they are always dilated, whereas in alcoholic coma they are pin-point; but they dilate if the patient be roused, returning very gradually to their contracted state when the patient is left at rest (the "Macewen pupil"). The temperature is generally subnormal in alcoholic coma.

In the coma of uræmia, diabetes or opium the odor of the breath will sometimes help; it is sweetish in uræmia, acetone- or chloroform-like in diabetes, and has a peculiarity of its own in opium poisoning. Examination of the fundus of the eyes should always be carried out to determine the presence or absence of retinitis, neuritis or atrophy of the disc.

In opium poisoning the pupils are pin-point and non-responsive. In diabetic coma they are dilated but react; and in uræmic coma they are dilated and react slowly.

The prognosis depends upon the nature of the compressing agent, its volume and the length of time it has been acting and whether it can be removed or not. When depressed bone is responsible, its elevation or removal is usually rapidly followed by disappearance of the symptoms. Blood-clot or pus, if either has been the compressing agent and acting for some time, may, even if removed, have led to such changes in the brain at the site of compression that it does not recover itself.

Diffused compressing agents such as effused blood, œdema of the membranes, and infective meningitis are usually fatal.

The treatment is to be carried out by removal of the cause by operative measures whenever that is possible.

THE COMPLICATIONS OF FRACTURES OF THE SKULL

Hemorrhage from the meningeal vessels may be either extra- or intradural or both. Extradural hemorrhage takes place either from the arteries or the venous sinuses of the dura mater; in some instances where rupture of the dura mater takes place, blood is found both outside and inside the dura (the "epanchement en bissac"); but extradural bleeding from the sinuses is rare; hemorrhage from this source almost always takes place into the subdural space.

The middle meningeal artery enters the skull by the foramen spinosum and divides into two branches, the anterior and posterior; the former curves upward and then turns backward over the meninges covering the frontal lobe, while the latter runs backward and upward toward the parietal eminence. The vessel is probably usually torn across by fissures of the bone passing over it. But it may be ruptured without any fracture at all, or without any fracture in the immediate neighborhood of the vessel. These cases are the result of the deformity of the skull that is caused at the moment of application of the violence, for the dura, being less elastic than the skull, does not react so rapidly and is separated from the bone, and the artery gets lacerated. In rare instances hemorrhage has occurred on both sides of the skull, the two arteries being injured directly by fractures of the bone over them; or in other cases by a fracture on one side and separation of the dura on the other.

It is not clear always from where the hemorrhage actually takes place—the trunk, the anterior or the posterior branch of the artery. In

the writer's experience the anterior branch and the trunk have been more often injured than has the posterior branch. Small thin clots (found at post-mortem examinations) result from tearing of minute twigs and probably give rise to no serious symptoms.

In ordinary cases when once the vessel is torn and the escape of blood started, the bleeding will continue until thrombosis occurs, or the pressure within the skull reaches that inside the artery; but it occasionally happens, when a fracture of the bones over or near the artery exists, that a gaping of the margins of the fracture is present, so that the blood has a free exit from the interior of the skull and forms an extracranial temporal hematoma which can reach a considerable size, and of course if a wound of the soft parts over this be present, the blood can escape externally and continuously.

These meningeal hemorrhages have been classified as diffuse or circumscribed.

The diffuse hematoma may extend over practically one-half of the cerebrum.

The circumscribed variety has been further subdivided into the fronto-temporal, temporo-parietal, parieto-occipital, occipital and sphenoidal; and of these the temporo-parietal is the type most frequently met with. The amount of clot found may be anything up to 9 ounces. From some extremely rare cases it would appear that an extradural clot of some magnitude may undergo absorption, but this is so rare that it ought never to be looked for; and a clot left to absorb may at any time become the seat of infection. The writer believes that small, thin clots as described above do not cause symptoms, and that these probably are frequently absorbed. Under still rarer conditions, probably, an aneurism may result from a rupture of the artery.

The Symptoms.—In a typical case of middle meningeal hemorrhage there is (1) a period of unconsciousness following immediately upon an injury to the head; this is the result of cerebral concussion, and it is a stage which lasts a varying length of time. It is followed by (2) a period of more or less complete consciousness (the so-called "lucid interval") and this is in turn succeeded by (3) a state of unconsciousness, gradual in its onset and ushered in by headache, vomiting, drowsiness, often followed by signs of localized pressure upon the brain, coma, and the typical signs of "compression."

Great importance is attached to the "lucid interval" as an aid to the diagnosis of a hemorrhage from this source. Jacobson found it present in 50 per cent., and Weissmann in 55 per cent. of his collected series of

257 cases. It should always be inquired for in any suspected case; but it may never be present at all, generally because of injury to vessels within the dura mater at the time the meningeal artery was ruptured, in consequence of which rapid compression is brought about. In some cases (they are uncommon) compression signs may be present from the outset as the result of depressed bone. In another class of cases the lucid interval may not be recognized owing to alcoholic intoxication of the patient. In yet another class, compression signs may be absent in consequence of (1) a free escape of blood from the cranial cavity to the exterior through a fracture as indicated already, or (2) a free escape of cerebro-spinal fluid, *e.g.*, from the auditory meatus.

When localized compression of the brain is brought about, it almost invariably is in the form of a contralateral paralysis the upper and lower extremities of the opposite side of the body being generally involved; and, while paralysis of the upper limb alone is met with, an isolated paralysis of the lower limb is practically never seen.

Twitchings and convulsive movements of the limbs, occasionally met with, indicate injury below the dura mater. In some very rare cases collateral paralysis (paralysis of the limbs on the same side as the clot) has been recorded. The explanation of this is not altogether clear, but it is probable that it is not due to the absence of decussation of the pyramidal tracts as some observers have suggested.

The pulse and respiration are altered in accordance with the state of the patient; that is, during the early concussion state the pulse tends to be small and quick, while respiration is shallow and sighing; in the later stage of compression the pulse is slow and full, and the respiration slow and deep and often stertorous in character.

Changes are to be observed in the pupils in most cases, though unfortunately they are by no means constant. Weissmann in his series of collected cases found that an alteration in the pupils was noted in 70; in 39 of these both pupils were wide and reactionless; in 7 cases both were extremely narrowed; in 20 cases the pupil on the same side as the extravasated blood was wide; and in 4 cases it was so on the side opposite to the hemorrhage. If the actual state of the pupils does not afford much help from the diagnostic point of view, it does from the prognostic aspect; for, with well-defined signs of compression, if both pupils are wide and do not react, the degree of compression is almost certainly great; whereas if both pupils are equal and react to light, the compression will probably be recovered from, if operation be successful in removing the clot. If possible, in every case an ophthal-

moscopic examination of the fundus of the eye should be carried out, when evidence of obstruction to the venous return may be obtained.

Sensory phenomena are seldom observed, probably owing to the state of unconsciousness.

The bladder and rectum are variously involved: at times one sees retention of urine with overflow; at others spontaneous though unconscious evacuation occurs. Incontinence of fæces is common.

The diagnosis of this condition is often a matter of the extremest difficulty, and in the absence of a definite history may be impossible until an exploratory operation is made.

In patients who are genuinely suffering from the effects of trauma, the diagnosis has to be made from (1) laceration of the brain, (2) subdural hemorrhage, (3) hemorrhage from one of the venous sinuses of the dura mater. In the last-mentioned condition the symptoms may be absolutely identical with those in an extradural hemorrhage.

In subdural hemorrhage the onset of compression symptoms is generally immediate, although in a certain number of patients there is a distinct history of a "lucid interval" and in such cases the diagnosis can only be cleared up by an exploration. Lumbar puncture in these cases will at times help, for in purely extradural hemorrhage the cerebro-spinal fluid is free of blood. In laceration of the brain the symptoms tend more to the irritative than to the paralytic type, the latter being more characteristic of the extradural injury. Fat embolism of the brain can lead to a series of symptoms, identical with those seen in middle meningeal hemorrhage; these cases are, however, very rare and practically invariably associated with a fracture of one of the long bones.

The prognosis must always be grave; it may be stated that practically every patient with an extradural clot of any magnitude who is not operated upon will die; absorption of the clot with recovery is so rare that one must never wait for it. Even where a clot has been successfully removed, death often follows: in some cases because there is injury to the brain or its vessels, but in other cases because the brain fails to expand again and compression symptoms persist in spite of the relief of the actual pressure by an operation. Weissman out of 257 cases found 90 per cent. died who were not operated on, and of those operated on 67 per cent. lived; out of the total 257, 65 per cent. died within the first 24 hours.

Treatment.—As soon as the diagnosis of extradural hemorrhage is suggested by the signs manifested by any patient who has received an injury to the skull, the artery on the side suspected ought to be exposed;

and, if no clot is found there, the artery on the other side should be seen also. Clot must be evacuated, and the bleeding artery tied whenever that is feasible. Quite frequently no bleeding point can be found, the hemorrhage is an "oozing," probably from many small branches of the vessel. In such a case the cavity must be lightly packed, the packing to be withdrawn later after thrombosis has taken place. In some rare instances where primary arrest of the hemorrhage has not been possible, there may be secondary bleeding, and one may be obliged to ligate the carotid artery, as once happened in the writer's practice.

There are various methods of locating upon the exterior of the skull, the position of the artery within. The writer has always found the following method satisfactory. At any point between 1 and 2½ inches directly posterior to the external angular process of the frontal bone, draw a vertical line from the upper border of the zygomatic process, equal in length to the distance selected from the angular process, and place the pin of the trephine on the skull at this spot, for the anterior branch of the artery. To expose the posterior branch the skull should be trephined ¾ in. behind and ¾ in. below the most prominent point of the parietal eminence.

If clot is not found on removal of the bone, some blunt instrument should be passed from the opening in *all* directions, and especially toward the base, in order to endeavor to tap the clot.

One often sees patients, profoundly unconscious and not moving any limb, after a head injury, and regarding whom no history may be forthcoming. Percussion of the skull is a help in these cases, and if a hollow or a cracked-pot note is obtained in the temporal region in such an individual, or, if a hematoma be present in the temporal region, the writer is strongly of opinion that the skull should be explored.

There are some cases in which it may be necessary to trephine at several points to thoroughly evacuate an extradural hematoma.

Hemorrhage from the venous sinuses of the dura mater is much less frequent than from the middle meningeal artery although produced in much the same manner. In addition to lacerations by fractures of the bones, or to penetration by sharp weapons, a sinus may be torn, owing to the change of shape of the skull as the result of the violence. There are several well-authenticated cases where a dural blood sinus was found ruptured in the absence of a fracture.

As in the case of bleeding from the meningeal artery, the hemorrhage may be inside or outside the dura or in both situations in the same patient. A fracture of the bone over the torn sinus may permit blood

to escape and form a hematoma beneath the scalp; while in some cases a depressed fracture may so compress the torn vessel that no bleeding occurs from it until the fragments are elevated at an operation. The superior longitudinal sinus and the lateral sinus have both been torn from deformation of the fœtal skull during labor.

The relative frequency of hemorrhage from the sinuses is rather difficult to estimate. Chipault in 117 cases of intracranial hemorrhage found 72 were from the meningeal artery and 30 from the sinuses, whereas Phelps in 300 cases of head injury found only 4 cases of sinus bleeding.

The longitudinal sinus was injured in 40 cases out of 76 collected by Wharton, the lateral in 26, and the cavernous in 3.

Extradural hemorrhage from one of these sinuses is not extensive, as a rule, unless the blood can escape from the skull, for the blood pressure is low, and wide stripping of the dura from the bone does not take place easily.

In open injuries to the sinuses air may be aspirated into the lumen of the vessel, and the accident has been followed by death.

There are some cases in which a differential diagnosis between hemorrhage from a sinus or a meningeal artery cannot be established before operation. The discovery of a fracture over the site of one of the sinuses may lead one to suspect the possibility of injury to it.

Where hemorrhage takes place into the subdural space, signs of general compression usually develop rapidly, although in a certain number of cases convulsions, at times general, at others strictly localized in their origin and sequence, are seen. On the other hand, even with an intradural hemorrhage from this source, strictly localized paralysis (hemiplegia) has been observed; and there may be a lucid interval; Luys found that it was present in 67 out of 127 cases collected by him.

Prognosis.—The condition is not a slight one. Wharton found recovery occurred in only 25 out of 70, and Luys in 14 out of 36 cases. If the primary dangers, death from hemorrhage (when the wound of the sinus is an "open" one), or from compression of the brain are survived, septic thrombosis constitutes the most serious complication, with the possibility of pyemia, infective meningitis, or abscess of the brain as a result.

Treatment is to be directed toward the arrest of hemorrhage and the relief of pressure symptoms when they are present. For the actual arrest of the hemorrhage suture of the wound in the sinus has been suc-

cessful and, if feasible, is the ideal method to employ, but the tension of the walls of the sinus may be so great as to render it difficult. Ligation has been tried, and proved satisfactory in some cases, but it, too, may not be easy, and the attempt to do so may lead to injury of the brain, or of the pial vessels. Packing is sometimes efficacious; strips of gauze may be introduced between the bone and the sinus wall, or into the opening in the sinus itself and, if asepsis can be maintained, will allow clotting to go on satisfactorily.

Under the term "*sinus pericranii*" Stromeyer described a condition which results from trauma and in which there is formed a tumor containing blood and placed beneath the pericranium, communicating with a sinus of the dura or of the diploë. It is practically a venous aneurism; it pulsates, enlarges during straining efforts, and may be more or less reducible by pressure over its surface. One such case at least has been cured by excision.

Cerebral Laceration and Injury to the Vessels of the Pia Mater.—While laceration of the substance of the brain may be central or cortical, the latter is much more often seen and is practically always associated with more or less extensive injury to the vessels of the pia mater.

Laceration of the brain is brought about directly, *e.g.*, by depressed fragments of bone; or indirectly in consequence of (1) the change of shape of the skull and brain, the result of the violence, or (2) contre-coup (the brain being injured at the pole opposite to that which receives the brunt of the force) and, as such, is seen especially often at the poles of the frontal and temporo-sphenoidal lobes. Laceration by contre-coup is often extreme, whereas that due to direct injury is often comparatively slight.

That laceration of the brain can be caused by temporary deformation of the brain seems to be undoubted. The "bursts" of the surface of the brain seen in the case of children—"bursts" which may extend from the cortex into one of the lateral ventricles—are certainly produced in this manner, and the lacerations of the substance of the white matter of the cerebrum, pons or cerebellum which may occur without any macroscopic evidence of injury to the cortex must arise from this cause. These central lacerations may lead to great effusions of blood which at times can reach the ventricles and escape thence into the subarachnoid space—effusions so great that death takes place rapidly from compression of the brain. On the other hand, they may be small in extent and ultimately undergo absorption.

Cortical lacerations when extensive are generally the result of a

contre-coup, the brain impinging against the internal wall of the skull. The writer believes that the theory of a separation, a tearing, which takes place between the gray and the white matter of the cortex in consequence of a difference in their specific weights explains some of these cases; for lacerations are seen where contre-coup does not explain their presence, and in the immediate proximity to almost every laceration one can see minute hemorrhages between the gray and white matter for some distance.

With the laceration of the brain cortex, rupture of some pial vessels takes place and hemorrhage ensues. In a considerable number of cases rupture of these vessels occurs over a large area and often with strictly localized laceration of the brain at one or two points only; these cases of pial hemorrhage are certainly the result of the shakings and deformation of the brain. The hemorrhage in these latter cases is often diffused over the whole surface without rupture of the overlying arachnoid so that the blood forms a thinly spread-out layer over the convolutions, filling the sulci and producing an appearance that is quite characteristic and one that is only simulated in anthracæmia; in the latter case, however, the evidence of laceration of the brain is wanting and the bacillus is to be found in the blood.

In other traumatic cases the arachnoid is ruptured; the blood escapes from below it into the subdural space, and extensive subdural hematomata may form, the blood tending to gravitate into the middle and posterior fossæ of the skull and down into the spinal canal.

In cases of *diffused hemorrhage* arising in this manner patients pass rapidly into the state of compression of the brain which will progress to a fatal termination, unless operation can give relief. The majority of patients suffering from this condition are in such a serious state when they come under the observation of a surgeon that the question of an operation is hopeless. If there be any chance of being able to complete an operation, the writer is strongly of the opinion that it ought to be carried out: although the greater number of patients still die in spite of it, it will occasionally happen that a life is prolonged.

The *Circumscribed Subdural Hemorrhage* is invariably, one may say, associated with localized cerebral laceration, the violence at the same time causing rupture of some of the pia-arachnoid vessels.

The frequency with which these lacerations occur upon the inferior surface of the frontal lobes and at the anterior pole of the temporo-sphenoidal lobes has been alluded to, but any portion of the brain's surface may be affected. They occur upon the mesial aspect of the cerebral

hemisphere as well as upon the convexity: some of these cases are the result or the impact of the brain against the falx cerebri; others are tears due to deformation of the brain at the moment of impact of the violence.

To the naked eye a recent laceration shows an appearance not inaptly compared to that of black currant jelly. The disintegrated tissue mingled with blood-clot may undergo a gradual absorption and ultimately result in a cicatrix which may be solid but is often cystic; at one time a single cyst is formed, but at others numerous small cysts are developed, and a spongy cicatrix is the result. The fluid contained in such cysts may be clear but is often tinged with the disintegration products of blood coloring matter. The cicatrices themselves contain cholesterin and remain pigmented for years. Until cicatrization is complete there is always the possibility of hemorrhage occurring from the granulations and the development of the so-called "traumatic late apoplexy." In a certain number of cases of cerebral laceration a spreading œdema of the soft membranes and underlying brain may develop, leading to a severe and fatal compression of the brain.

Infection of the injured area may be set up at any time; directly when wounds of the scalp and bone exist, or indirectly (though more rarely) through the medium of the blood stream, and so an encephalitis or a meningitis can be established.

The symptoms which follow in these injuries are very varied and are dependent upon the area of the brain involved and the amount of hemorrhage associated with the injury. Where the hemorrhage is excessive and diffused, general symptoms of compression are rapidly established. Even in the slight degrees of laceration patients are thrown at the moment into a state of unconsciousness due to concussion, from which they generally recover, though not completely.

In one type of the condition which is fairly characteristic and generally associated with superficial lacerations of the frontal and temporal lobes the patient lies in a state of general flexion which is at once resumed should any attempt be made to extend the limbs; while the head is often kept buried in the pillow or bedclothes. The patient takes no notice of his surroundings, often moans, and when disturbed resists, grinds the teeth, and, if sufficiently educated, often swears. There is resistance to attempts at opening the eyelids, which are always firmly closed, but when the pupils can be seen in this stage, they are of medium size and react to light. Swallowing is not interfered with. Urine and fæces are frequently passed involuntarily. The temperature

in the early stage is subnormal but after 24 hours is always elevated. In the early stage the patient lies quietly but, as the condition passes off, becomes restless, and headache is complained of, generally in the frontal region. This condition constitutes what is known as "Cerebral Irritation." If the laceration is in the Rolandic area, Jacksonian convulsive seizures may be met with, but frequently a monoplegia or, in other instances, a weakness or a paralysis of both limbs on the side opposite to the damaged area will be seen. The facial muscles are involved in some cases, and if Broca's convolution should be implicated there will be motor aphasia.

A lesion at the angular gyrus has been known to produce word-blindness; one involving the superior temporo-sphenoidal convolution will bring about a state of word-deafness, and one implicating the occipital lobe, especially if near the parieto-occipital fissure, will cause a hemianopia.

Patients who suffer from laceration occasionally develop signs of compression, the result of an œdema of the soft membranes and of the brain, comparatively localized in some cases and general in others, and not a few deaths result from this cause. With this œdema it is not uncommon in the writer's experience to see evidence of transient and evanescent paralysis of one or other of the cranial nerves (the 3rd or 6th being most often affected) due probably to effusion into or around the nerve sheaths.

A degree of choked disc will very constantly be found to be present if looked for.

The temperature is very generally elevated at some stage. Subnormal to begin with, if the patient does not die in the early period, it will rise; it may do so rapidly and reach a state of hyperpyrexia within a few hours and almost every patient in whom this happens will die. The temperature rises in some cases to 102°F. or thereabouts, remains at that level for a varying period, to fall in the cases which recover, but rising in others and then usually ending in death.

When hemorrhage occurs from lacerations at the base of the brain or gravitates into the posterior fossæ, it is very usual to find an extreme degree of rigidity of the patient's neck and a difficulty in swallowing, both symptoms due to interference with the last cranial nerves (10th, 11th and 12th) and the higher cervical nerves by the blood and serum exuded.

It is these lacerations of the brain that give rise to the so-called "traumatic late apoplexy." Under this term Bollinger described

cases of what is really a secondary hemorrhage taking place as the result of softening and necrosis of brain tissue following contusions and lacerations.

Such hemorrhages may come on days or weeks after the primary injury, from which the patient may have recovered to a certain extent though not completely; he may be suffering from a slight degree of cerebral irritation, headaches, disturbed sleep and more or less mental irritability. These signs are present over a varying period in a large number of cases of cerebral contusion that gradually recover, but in that class of patients who ultimately develop symptoms of the traumatic late apoplexy (viz.: paresis developing into localized paralysis, with or without epileptiform seizures, indications, that is, of localized pressure) they are spoken of as constituting the "latent" period.

The treatment of circumscribed subdural hematomata must be by operation. When the area of brain that is injured is extensive, the hemorrhage in the early stage can be sufficient to produce a condition of general compression. The site for operation is to be decided upon by a consideration of the nature of the accident as far as is known, of the evidence of bruising of the scalp, and the results of percussion of the skull for the determination of a possible fracture. Contusions and hemorrhages are very constantly at the opposite pole of the skull from that assaulted and it is frequently necessary to operate at both poles.

Blood and brain débris must be gently removed, the cavity explored as to its extent, and very often secondary openings require to be made in the bone to permit thorough evacuation and drainage. Where localizing symptoms are present they point to the situation at which the skull is to be opened.

There is still a large group of cases in which operation may not be required until symptoms of distinct compression arise. The causes of this compression are either œdema of the soft membranes, further hemorrhage (traumatic late apoplexy), or infections (meningitis or abscess formation). The writer believes that free purgation by sulphate of magnesia is of great service in many cases where a compression operation is not indicated, by tending to lower blood pressure, and that venesection also has value.

Lumbar puncture has been advocated as a means of diminishing intracranial tension but in the writer's experience does not appear to have any great effect.

Every patient who suffers from contusion or laceration of the brain ought to be kept at most complete rest and quiet, by preference in a

darkened room, and at least until every trace of mental irritability, headache, etc., has passed off. The writer is unable to appreciate the supposed benefit of giving these patients early "mental exercise," as has been recently advocated.

The patients who suffer from cerebral irritation require to be kept quiet. If marked restlessness shows, bromides or opium will prove useful.

In connection with the subject of Subdural Hemorrhage mention requires to be made of the hemorrhages which take place over the fœtal brain during labor. During long and difficult labor, which may or may not be instrumental, hemorrhages occur in certain cases. They may be over the vertex of the brain or at the base: in the latter case they are frequently in the posterior fossa and generally prove fatal. The hemorrhage is usually subdural but may be confined to the meshes of the pia mater. It occurs very generally over the Rolandic region when at the vertex, and is often bilateral. The hemorrhage is probably greatest, *i.e.*, the clot is thickest, near the superior longitudinal sinus, and may extend down the mesial surface of the hemisphere. As a result, when the child survives, spastic paraplegia is developed affecting one or both sides of the body (Little's Disease) and, not infrequently, is associated with epilepsies of the Jacksonian type. If the hemorrhage extends beyond the Rolandic convolutions the mental powers of the child may be seriously interfered with.

There is little doubt that the prolonged labor, and the resulting compression of the head and asphyxia, are the active causes of these hemorrhages, but it is remarkable that so many of these infants give a positive Wassermann reaction.

After a long labor, a child the subject of a hemorrhage of this nature shows evidences of intracranial pressure. The fontanelle bulges, the scalp veins are unduly prominent, the infant may be difficult to rouse. More localizing signs are found in inability to move one or more of the limbs, or in twitchings or rigidity or actual convulsive seizures.

A lumbar puncture will, in the case of blood escaping into the subdural space, be of help as a diagnostic point, but where the hemorrhage is confined by the pia mater, blood is not found in the cerebro-spinal fluid.

The patients with basal hemorrhages die early. Swallowing may be a difficulty in these cases.

Treatment to be effective must be by means of operation, and if this

is to be useful it must be carried out early, while there is a possibility of being able to remove the clot, within the first two weeks; otherwise it will be anchored to the brain and pia mater by granulation tissue penetrating it in the process of absorption.

Pulsating exophthalmos is a somewhat rare condition seen after traumata of the skull, as the result of which there is brought about a communication between the internal carotid artery and the cavernous sinus. The affection may result from direct injury to the vessels by objects penetrating through the orbit, or indirectly from violence applied at a distance.

Signs of the lesion are not usually evident immediately after the injury, being masked by the symptoms of the head lesions, but they are generally fully developed within nine months of the accident, and frequently within two. The typical symptoms are exophthalmos, pulsation of the eyeball, *bruit*, and noises in the head, distention of conjunctival vessels, paralysis of extrinsic ocular muscles, and of the iris, with or without anæsthesia. Vision may be greatly diminished or lost altogether, and in the early stages there may be a choked disc which may run on into atrophy.

While spontaneous retrocession and cure of the tumor has been known to take place, it is extremely rare.

Treatment by ligation of the common carotid artery has given very favorable results.

WOUNDS OF THE BRAIN

Wounds of the Brain.—Wounds of the brain are only seen as com plications of injury to the skull itself, except in the rare instances in which penetration of the cranial cavity takes place directly through the orbit and orbital fissure by pointed objects without a fracture being associated therewith. Apart from these uncommon injuries, wounds of the brain are met with as the result of depressed fractures, or are the consequence of sword, hatchet, bullet or circular saw injuries.

These injuries to the brain are of much importance, for practically every wound of the brain is a contused wound, and every wound not made by a surgeon is an infected wound; it is infection that gives the importance to the type of injury under consideration.

Daggers and other objects which produce penetrating wounds may be broken off and part of the blade be left in the cranial cavity, or the ferrule of a walking stick may remain inside the skull. Such foreign

bodies may give no trouble at the time of the injury but around them an abscess may ultimately develop. The wound inflicted by a hatchet or sword, by which a slice of the skull wall is elevated or cut clean away and the membranes, brain, etc., beneath, variously injured but always in part crushed, is perhaps less dangerous than many others, for with a large opening in the bone there is a free vent for drainage, and tension need not arise within the skull.

The treatment as far as the actual injury to the brain is concerned is to be directed to the removal of foreign bodies, hair, dirt of all kinds, portions of the injuring weapon, etc. Bruised particles of the brain are to be gently washed away and provision made for drainage. The wound in the soft parts should be left open until asepsis is assured. The question of attempting to close the opening in the skull may eventually have to be considered.

Hernia of the Brain.—As met with after traumatism, a cerebral hernia is always associated with the presence of sepsis in consequence of which a mass of granulation tissue, derived from the brain, protrudes through an opening in the membranes, skull and scalp. It appears as a red mushroom-shaped tumor showing here and there signs of localized necrosis or hemorrhage, with patches of a yellow-white fibrinous exudation at its surface. The tumor may or may not pulsate, it often becomes tenser during forced expiratory efforts of the patient.

A puriform leptomeningitis is not infrequently established with death as the ultimate outcome. But, in cases where the virulence of the infecting organism is not great, a sealing off of the arachnoid space can take place in consequence of which the infective process remains localized. Such cases may terminate in recovery if the sepsis can be overcome; it may be only after gangrene of considerable masses of the granulation tissue forming the tumor, during which process there is a risk that the cavity of the lateral ventricle may be opened into and a general leptomeningitis be established; but if this accident does not occur the tumor shrinks to the level of the skull and will cicatrize over. There is always the possibility, however, of serious psychical changes developing in such cases.

Treatment must be preventive, and cerebral hernia is now-a-days a condition only rarely met with. When a hernia is developing, free removal of the bone around, without any interference whatever with the membranes, and the employment of aseptic dressings is probably the best line to pursue until such time as recession and shrinkage of the tumor shall have taken place.

The Intracranial Infections.—Infective organisms may be directly implanted, carried straight to the site of their action, as the result of penetrating wounds of the vault or the base of the skull; or may reach the interior of the skull secondarily, by continuity of tissue through open fractures; or, arising in a septic abrasion of the scalp or an infective osteitis, without any fracture, and spreading along thrombosed vessels, may lead to a meningitis, abscess of the brain, or, less frequently, to a sinus phlebitis.

But, on the other hand, given a zone of contused brain tissue—an extravasation of blood beneath the arachnoid or outside the dura mater—infection may reach the dead tissue, clot, etc., by the blood stream from some distant focus in the body.

The causal agents of the infection in these cases may be any of the ordinary pus-producing organisms. When the infection arises from the nasopharynx or middle ear, as is not infrequently the case in basal fractures, the pneumococcus is generally at fault.

A meningitis may be limited to the dura mater (pachymeningitis), in which case it is generally localized to form an extradural abscess, but an abscess may form between the dura and the brain, the general subdural space being closed off by adhesions between the arachnoid and the dura. If infection spreads through the dura mater, whether owing to the latter's having been lacerated at the accident or from mere continuity of tissue, it is more usual for a diffuse leptomeningitis to be established.

Symptoms of meningitis following upon trauma may develop within three days of the injury or may be delayed for three weeks or longer; the more directly the infection occurs, the more rapid is the development of symptoms. These manifest themselves by the onset of headache, restlessness, a sudden rise of temperature to 103°F.–105°F., quick pulse (the pulse of septic intoxication and not of compression, although there is increased intracranial tension), rapid respiration, weakness, often marked rigidity, of the limbs which occasionally develops into a complete paralysis; at times there are convulsive seizures. Vomiting is uncommon, and a rigor is on the whole rare. In basal meningitis ocular palsies or interference with one of the facial nerves may be met with; and when the infective process reaches the posterior fossa and the membranes over the medulla and upper cervical cord, there is difficulty in swallowing and rigidity of the neck muscles.

The pupils are often unequal, and as the tension increases within the skull they dilate. A choked disc will often be found if looked for.

The bowels are generally constipated; the urine is often passed involuntarily. By lumbar puncture turbid fluid due to the presence of leucocytes and organisms is obtained.

In those cases where an extra or subdural abscess develops in the absence of a wound of the scalp of greater extent than an abrasion, it will often be found that a zone of œdema of the scalp forms in the immediate neighborhood of the pus. It is never a large swelling and can readily be overlooked. It is known as Pott's "puffy tumor," after Percival Pott who first drew attention to it. It is a sign of consequence, for in the absence of definite localizing signs, such as paralysis of a defined group of muscles or convulsive seizures, its presence indicates one spot for exposing the bone, and in most cases for a trephine opening to be made.

Thrombosis of the Sinuses of the Dura Mater.—Sinus thrombosis is generally seen as a complication of septic wounds of the scalp or skull, thrombosis of some tributary vein occurring in the first place and spreading to the larger vessel. But in rare cases it is seen as a complication of a meningitis.

The clot frequently disintegrates and, especially in the case of the lateral sinus, leads to pyæmia, secondary metastatic abscesses forming in the lungs particularly, and immediately under the pleural coverings.

The superior longitudinal sinus is specially prone to be involved in fractures of the vault; the lateral sinuses in fractures of the posterior fossa, particularly those traversing the tympanum or mastoid process, and the cavernous sinus in fractures of the base of the middle fossa.

The signs of involvement of the cavernous sinus are fairly characteristic, the most obvious being the protrusion of the eyeball and œdema of the eyelids, sometimes also of the conjunctiva, with paralysis of one or more, or all, of the ocular muscles of the same side, a fixed dilated pupil and the existence of a choked disc.

With thrombosis of the superior longitudinal sinus epistaxis is said to be common, and the veins of the scalp are prominent.

Thrombosis of the lateral sinus, and especially after the sigmoid and the bulb of the jugular vein have been affected, may lead to an œdema over, or just below, the mastoid process; and if the thrombus extends along the jugular vein one can feel a thickened, cord-like mass along the course of the vessel in the neck.

In all cases pain in the head is present, and vomiting may occur early. With disintegration of the clot and the dissemination of emboli there is a lighting up of marked symptoms. Very generally a rigor

leads off, to be repeated at intervals, with rise of temperature which fluctuates within wide limits during the course of the disease. The pulse is rapid and small. The tongue becomes dry and brown; sordes develop on the teeth. The lungs are often involved; patients complain of pain in the chest, develop a cough with a dirty prune-colored and often very foul expectoration. The physical signs of pleurisy may be present; occasionally one of the abscesses bursts into the pleural cavity and a diffuse effusion is established.

In other cases there is an inveterate diarrhœa with offensive stools, not unlike what is seen in enteric fever.

If a meningitis is not set up secondarily, it is remarkable how long these patients may go without loss of consciousness, and how long they live even when the case is going on to a fatal termination.

Encephalitis and Cerebral Abscess.—Encephalitis can seldom be distinguished from meningitis (the two being almost invariably associated) in traumatic cases.

Cerebral abscess following upon trauma may be acute or chronic. The former arises from infection reaching an area of brain tissue in a state of red softening.

The chronic abscess may exist for long periods but at any time may be lighted up to fresh activity. The brain surrounding these abscesses is practically normal in appearance.

The traumatic cerebral abscess is generally the result of injury to the vertex of the cerebrum and is usually seated in either the frontal or the parietal lobe.

The early symptoms are indefinite, but pain in the head is present in most cases from an early stage. A rigor or series of rigors may herald the more obvious cerebral symptoms of vomiting, drowsiness and slow mental efforts. The pulse, respiration and temperature, in the early stage, may be elevated, but later the temperature falls and the pulse and respiration become slowed.

Paralysis (mono- or hemiplegia, or facial in its type) may manifest itself along with dilated pupils and choked discs. Emaciation is a pronounced feature in the chronic abscess cases particularly. Evidence of Pott's puffy tumor should be looked for in traumatic cases. Infection is generally in the neighborhood of the direct injury but may be at a part injured by contre-coup.

The treatment of these infective complications of traumatism must, in the first place, be preventive by the most scrupulous asepsis of all wounds of the scalp and of the bone.

Wounds of the scalp require to be examined thoroughly; their margins cut out, and often the whole of their surface, to get rid of dirt particles that are so frequently ground into them. In the same way, the surface of exposed bone ought to be chiselled off whenever there is any evidence of ingraining with dirt; and if there be any doubt as to a wound having been made aseptic, it is better to leave it open and allow it to granulate, rather than to suture it up and fail.

Abscesses require to be drained; and, of the three types of infection, they offer the most hopeful outlook.

A thrombosed sinus when accessible should be opened up freely, the infected clot removed and the lumen of the vessel packed. If a transverse or sigmoid sinus be involved, ligation of the internal jugular vein in the neck should be carried out, in the hope of preventing dissemination of infected emboli. While the prognosis in these cases is not good, it is not quite so hopeless as in the meningeal cases, almost every one of which is fatal.

Head injuries can undoubtedly act as a predisposing cause to the onset of tuberculous meningitis; and it is not less certain that in a patient with syphilitic infection a cerebral trauma may be a cause of a syphilitic meningitis.

THE AFTER-EFFECTS OF HEAD INJURY

Any patient who has sustained an injury to the head, and especially one which has caused unconsciousness, may develop, soon or late, one or other of the following conditions, (1) traumatic cephalalgia, (2) traumatic psychasthenia, (neurasthenia) (3) traumatic epilepsy, (4) insanity.

Traumatic cephalalgia is due to irritable or painful scars, sclerosis of bone, irregularities of the internal table of the skull, cysts or thickenings of the membranes, or to œdema of the brain or adhesions of the membranes to the brain. The headaches, frequently made worse by sudden movements of the head, are either generalized or local, the latter often neuralgic in type; and either may exist with or without local tenderness on percussion. Treatment is by rest and such drugs as aspirin and phenacetin internally. These cases of localized headache (particularly if associated with local tenderness) are at times benefited by trephining. When this is done the dura mater ought always to be incised to permit of an examination of its own texture and the state of the underlying soft membranes and brain.

Traumatic psychasthenia (*neurasthenia*) like traumatic epilepsy and insanity is more prone to develop in a patient in whom there is a family predisposition to neurotic states. Any of the three conditions may develop after what are comparatively slight head injuries, just the type of case which there may be a tendency to treat too lightly.

Traumatic psychasthenia results from "psychical shock." "It may be that it is the result of bio-chemical or bio-physical interference with the function of the neurones which form the substratum of consciousness" (Mott). Weber believes that minute hemorrhages with the small cell exudation around may not only cause transient brain disturbance but can lead to permanent changes.

Patients suffering from the slight degrees of this condition show no outward change in character but there is a disturbance in their powers of perception, with or without loss of memory. The loss of memory may concern events prior to the accident, or details regarding the occurrence of the accident, or there may be a permanent impairment of the power of remembering facts.

In more severe cases there is an inability to maintain mental effort. Patients become irresolute, fear lest they make mistakes, cannot manage their money matters, suffer from insomnia, and become morose or hypochondriacal, and if there is any tendency to insanity, may develop delusions.

In the severest type there is pronounced mental confusion following upon a somnolent stage, associated with delirium and sometimes with hallucinations. There is disturbance of orientation of time and space, and there is diminution in the powers of perception. Patients make mistakes in the identification of persons, and there is loss of memory ("*Korsakow's psychosis*").

Following upon injuries to the skull, especially in countries where the law decrees that compensation shall be paid for industrial and other accidents, there is a remarkable tendency to exaggerate symptoms and even to simulation; and it is not always easy to distinguish between the genuine and the simulated case. The malingerer probably tends to overdo it. The real sufferer exhibits a tendency to lethargy, cannot rouse himself, likes to be alone, and suffers loss of memory; while the malingerer can often remember and describe in great detail the events that occurred at the time of the accident, and enjoys companionship.

Traumatic epilepsy follows upon direct irritation of the brain, the result of thickenings or depressions of the internal table, meningeal or cortical changes, scars, cysts, etc.

In persons with a latent tendency to epilepsy the outbreak of the active manifestations of that disease can be lighted up by cerebral traumatism of even the slightest degree, and where no obvious lesions can be discovered microscopically. In such cases the epilepsy is always generalized in type.

In the class with clearly evident lesions the epilepsy may be either generalized or, if the lesion be in the neighborhood of the specialized centers of the brain, may be Jacksonian in type. The treatment of these conditions must, on the whole, be considered as decidedly unsatisfactory. The hopes that were raised in the early days of surgical interference in this class of patient have not been realized.

The cases of generalized epilepsy are not suited for surgical treatment. Those cases in which there is a definite Jacksonian seizure following upon trauma, and where there is no neurotic history, offer the best chance of amelioration or cure by surgery, and the earlier the operation is done the better.

Traumatic Insanity.—While it is quite clear that insanity can follow upon injury to the brain, the frequency with which it occurs is variously estimated. It is probable that trauma is a rare cause. Insanity may follow as a direct result of the injury but a predisposing neurotic element is of far greater importance. In some instances an injury leading to psychasthenia develops into insanity, or insanity may follow on a case of traumatic epilepsy.

General paralysis of the insane may be lighted up by cerebral injury in a patient predisposed to it (*i.e.*, a syphilitic). Köppen describes under the term "Dementia post-traumatica," a condition which is liable to be mistaken for general paralysis, but which occurs without gross pathological findings.

The treatment of traumatic insanity is altogether unsatisfactory. Operation is justified only where there is a definite localizing sign or symptom.

As has been shown above, the skull may have to be opened temporarily or permanently for a varied series of conditions arising from traumatism. Thus, after certain fractures it will be necessary to readjust (by elevation of fragments in the majority of cases but by depression in a certain minority) the deformity which has been brought about.

In a large proportion of cases these deformations are subcutaneous and closed; so that, during the process of exposing them, hemorrhage from the vessels of the scalp has to be dealt with; and various measures

have been proposed and adopted to control it. A rubber tourniquet placed round the lowest level of the scalp, passing below the occipital protuberance and the frontal eminences, is employed by some surgeons; or the hemostatic pins of Vorschütz; or the compression bars of Kredl; or sutures passed through and under the scalp and surrounding the whole area of the operation, are used by others; while others again trust to catching the vessels in forceps as they are divided.

Excepting the cases (and they are comparatively rare after traumatism) where it is necessary to expose a large area of bone by turning down a considerable flap of the scalp, it will generally be found sufficient to rely upon the use of forceps to take the vessels as they are cut; but for the more extensive operations the writer prefers the encircling sutures.

Whenever it is feasible it ought to be the aim to reimplant any bone which it has been found necessary to remove during an operation; but this is only possible when one is assured of the asepsis of the wound. When one is dealing with a closed fracture there ought to be no difficulty in this respect; and in the case of an open fracture it may often be done with success. Where the outer surface of the bone fragments is ingrained with dirt, if the fragments are split along the diploë, the internal table can often be reimplanted.

When the skull is opened in infective diseases the bone cannot be replaced; and it may be necessary or advisable to close the gap at a later period by one of the methods already alluded to.

In many operations one requires to open the skull over a definite area of the brain; and for this purpose it is necessary that one should be able to mark out upon the scalp the principal fissures and areas of the subjacent brain.

Several methods have been employed for this object; in the writer's opinion the simplest and most satisfactory is that of Professor Chiene, which entirely does away with the use of a cyrtometer, and is easy to bear in mind. The primary lines are drawn from bony points which are readily recognized. Mr. Chiene's directions are as follows (see Figs. 7 and 8).

"The head being shaved find in the mesial line of the skull between the glabella (G) and the external occipital protuberance (O) the following points: First, the mid-point ($4/8$) M; second, the three-quarter point ($6/8$) T; third the seven-eighth point S.

"Find also the external angular process (E), and the root of the zygoma (P), immediately above and in front of the external auditory meatus.

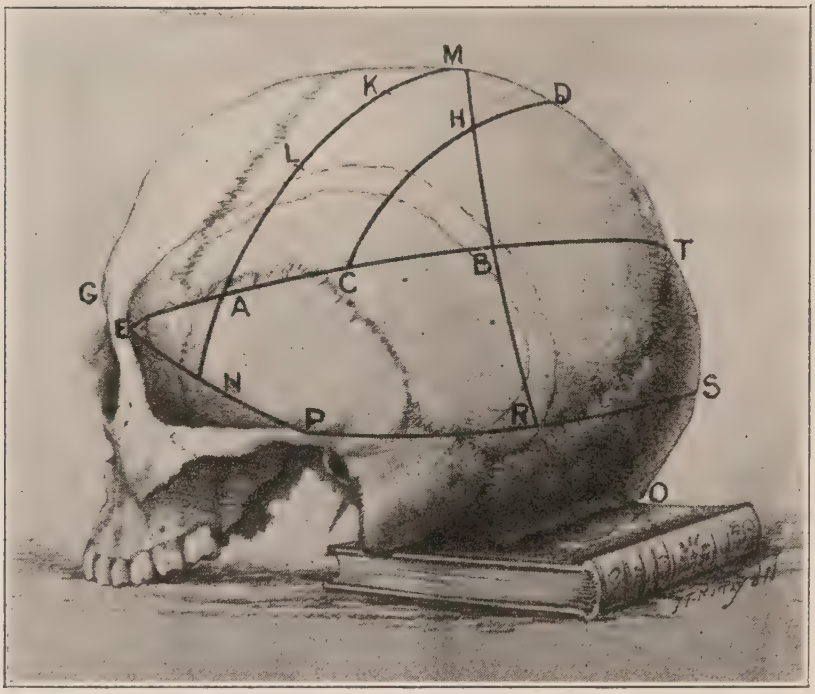


FIG. 7.—Chiene's lines. (*Chiene Ed. Med. Journ.*)

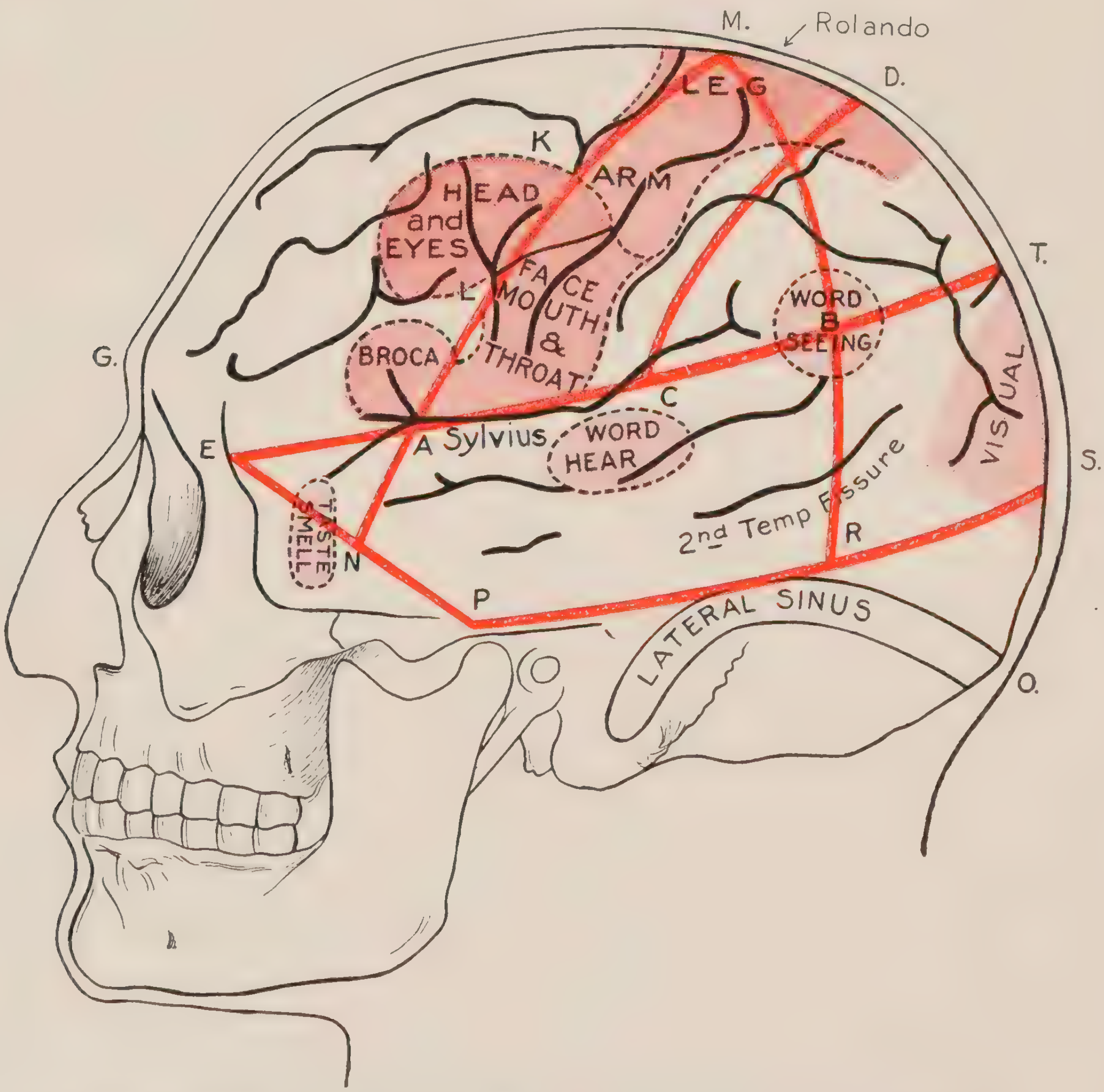


FIG. 8.—Cranio-cerebral topography. Chiene's lines in relation to main fissures and areas of the brain. (*After Stiles-Cunningham's Anatomy.*)

"Having found these five points, join EP, PS, and ET.

"Bisect EP and PS at N and R. Join NM and RM.

"Bisect also AB at C, and draw CD parallel to AM."

The parallelogram MDCA corresponds to the Rolandic area; the ascending frontal and parietal convolutions with the fissure of Rolando between them, and the anterior branch of the middle meningeal artery.

The line MA corresponds to the superior and inferior precentral sulci; and if it is trisected at K and L, these points will correspond to the origins of the superior and inferior frontal sulci.

The point A corresponds to the Sylvian point of the fissure of Sylvius, while AC follows the posterior horizontal limb of that fissure.

The pentagon ABRPN corresponds to the temporo-sphenoidal lobe, with the exception of its apex which is a little in front of N, with the center for taste and smell. The parallel sulcus lies three-quarters of an inch below the line AB. The angular gyrus is at B.

To mark out the fissure of Rolando on the scalp find the mid-point between the glabella and occipital protuberance, and at a point half an inch posterior to it draw a line $3\frac{3}{8}$ in. down and forward at an angle of 67° to the sagittal line. Chiene's method of finding the angle of 67° is useful: take a sheet of paper and fold it to half a right angle (45°) and again to a quarter of a right angle 22.5° when an angle of 67.5° is obtained.

BRANCHIAL SYSTEM

SECTION IV

DEVELOPMENT

By

J. FAIRBAIRN BINNIE, A. M., C. M., F. A. C. S.

The ovum or primary cell after fertilization undergoes segmentation, *i.e.*, it divides into two cells each of which in turn divides into two and thus the cells increasing by geometrical progression, a mass of cells soon results, the mulberry mass or morula (Fig. 9). Soon a cavity, situated eccentrically, appears in the morula and the mass of cells is converted into a hollow sphere, blastodermic vesicle, consisting of a covering membrane (zona pellucida lined by a single layer of cells called the

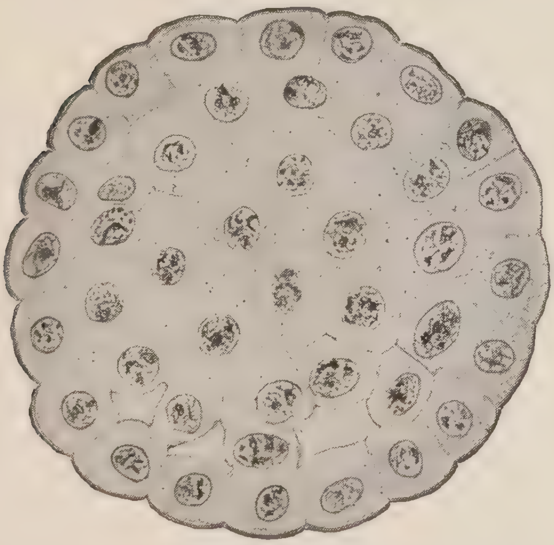


FIG. 9.—Diagram of section through a mammalian ovum at the morula stage. (*Morris' Anatomy.*)

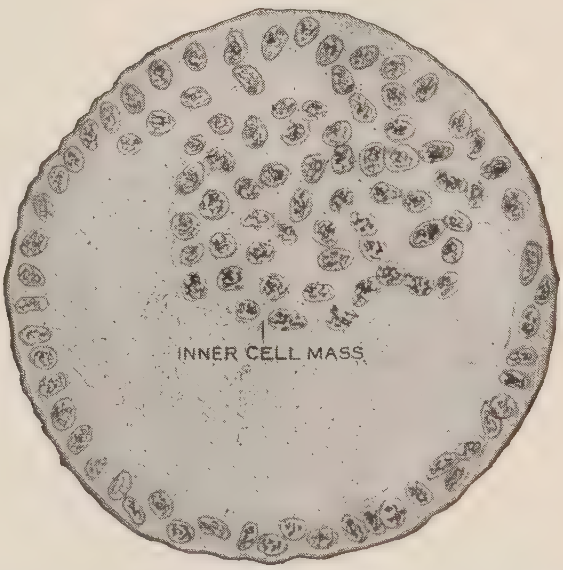


FIG. 10.—Diagram of section of a mammalian ovum showing the inner cell mass. (*Morris' Anatomy.*)

trophoblast, Fig. 10). At one point on the inner surface of the vesicle there is a mass of cells, the inner cell mass, which when looked at from the surface forms an opaque area on the vesicle to which is given the name embryonic area (Fig. 11).

In the more superficial part of the inner cell mass a cavity appears (Fig. 12), the amniotic cavity "and from the cells which form its floor the embryo develops, the remaining portion of the vesicle giving origin to structures concerned in the nutrition of the embryo" (McMurrich). The cells which form the embryo become differentiated and arranged in

two layers, the ectoderm (epiblast) and the endoderm (hypoblast). The ectoderm forms the floor of the amniotic cavity while the endoderm spreads itself over the inner surface of the vesicle. Between the ecto-

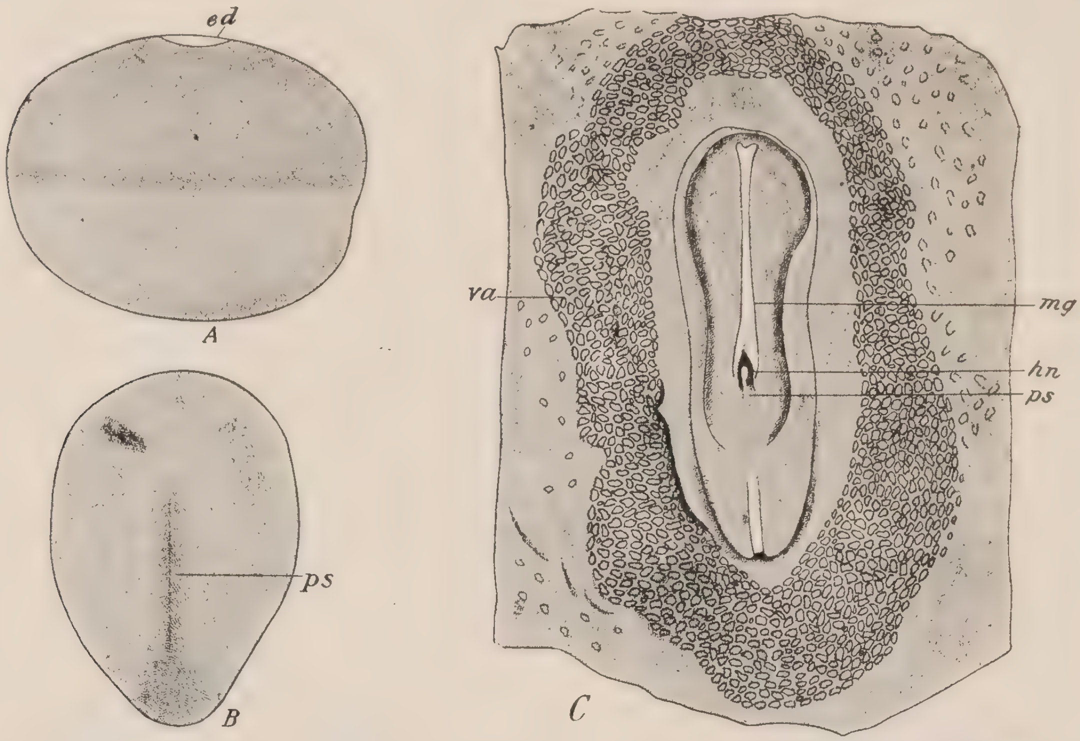


FIG. 11.—*A*, Side view of ovum of rabbit seven days old (*Kölliker*); *B*, embryonic disk of a mole (*Heape*); *C*, embryonic disk of a dog's ovum of about fifteen days (*Bonnet*). *ed*, Embryonic disk; *hn*, Hensen's node; *mg*, medullary groove, *ps*, primitive streak; *va*, vascular area.

and endoderm a third layer of cells soon appears, the mesoderm or mesoblast. These three layers become the parents of very different structures. The ectoderm provides the epidermis and the nervous

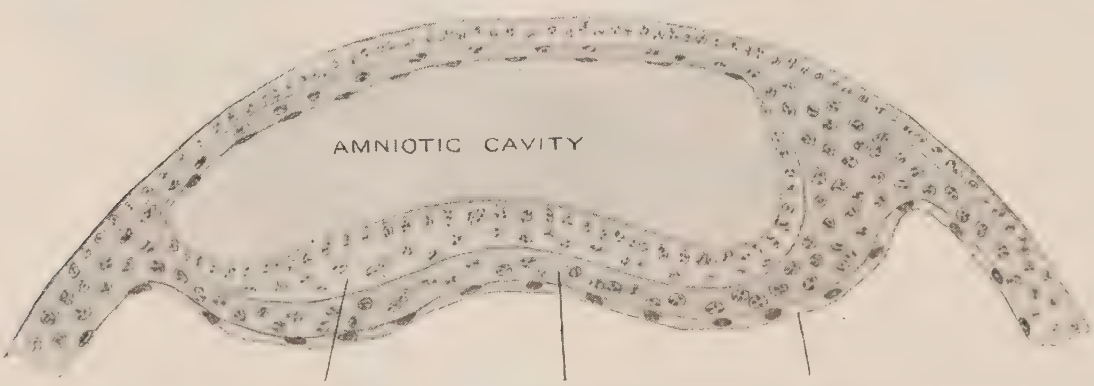


FIG. 12.—Diagram of section of a mammalian ovum showing the amniotic cavity and the embryonic germinal layers. (*Morris' Anatomy.*)

system; the endoderm provides the mucous membrane of the digestive tract with its derivatives (liver, lungs, thyroid, etc.), as well as the urinary bladder; the mesoderm provides the remaining organs (muscles, bones, etc.).

About this time a longitudinal groove appears on the surface of the embryonal area or disc, the medullary groove bounded by two ridges (medullary ridges) (Figs. 13 and 14). As the groove deepens the

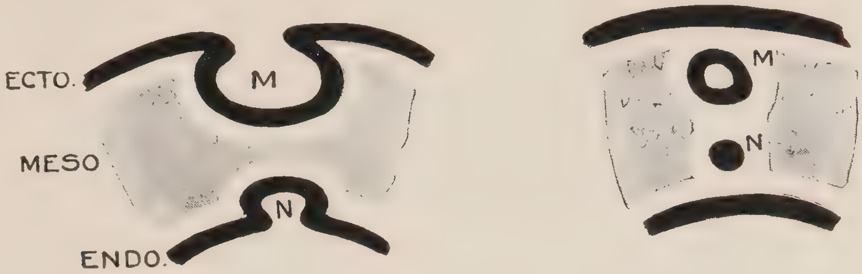


FIG. 13.—*M*, Medullary groove; *N*, notochord.

summits of the ridges come together and unite so that the medullary groove becomes a canal (medullary or neural canal) which runs the

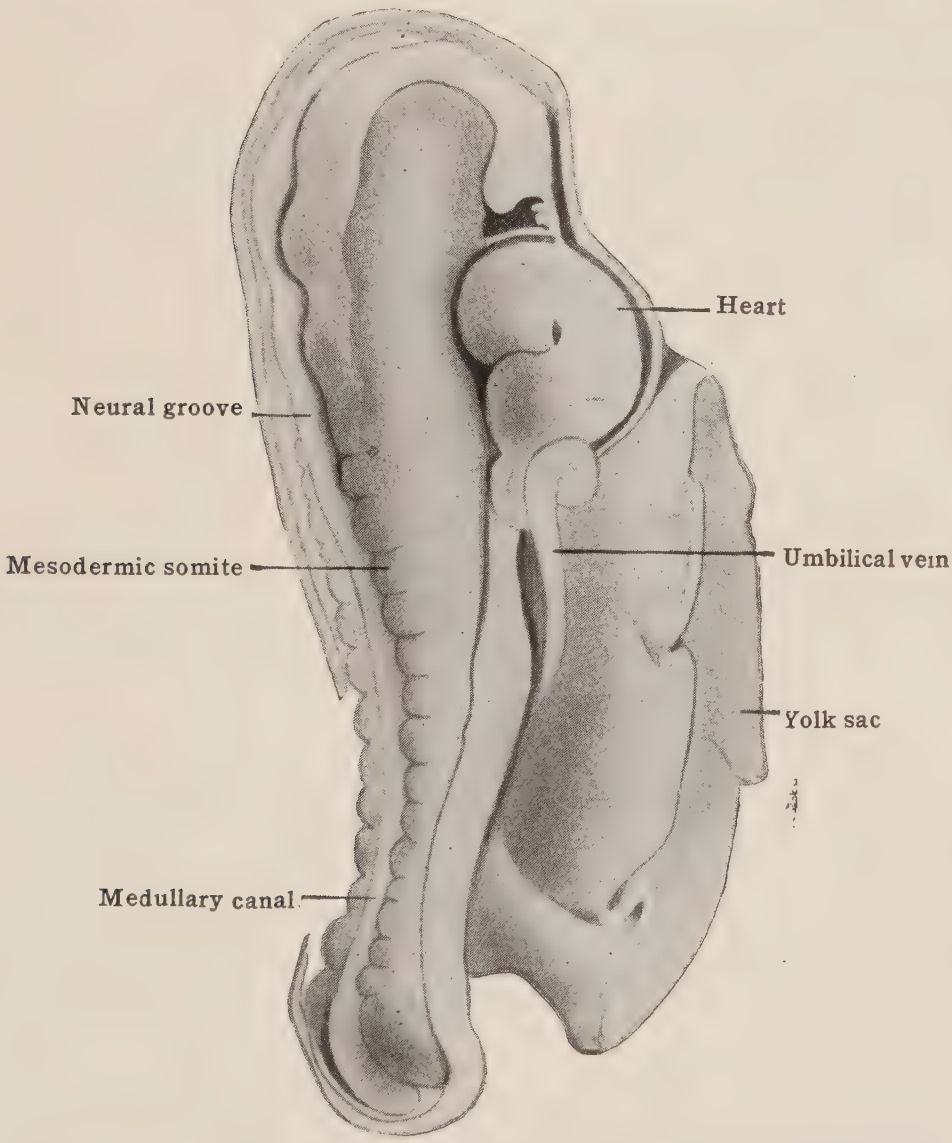


FIG. 14.—A human embryo 2.5 mm. in length. (*After Kollmann.*)

whole length of the embryo. The canal persists through life as the central canal of the spinal cord and the brain; the lining of the canal (ectodermic cells), forms the central nervous system.

At the same time a longitudinal groove appears on the lower surface of the embryonic disc (Fig. 13) resulting in the pinching off of a *solid* rod of endodermic cells. This rod, the notochord, is not a permanent structure. Many recent authorities (Lillie, Bardeen, F. P. Johnson) consider the notochord to be mesoblastic in origin.

The development of the medullary canal and the notochord divides the mesoderm longitudinally into two masses one on each side of the middle line. Each of these masses of mesoderm splits into two sheets one of which remains in contact with the ectoderm (somatic layer) the other with the endoderm (splanchnic layer). Near the medullary canal the two layers of mesoderm are continuous. A short distance laterally from its median edge, the mesoderm becomes constricted by longitudinal grooves until it becomes divided into a median or dorsal band and a lateral or ventral portion.

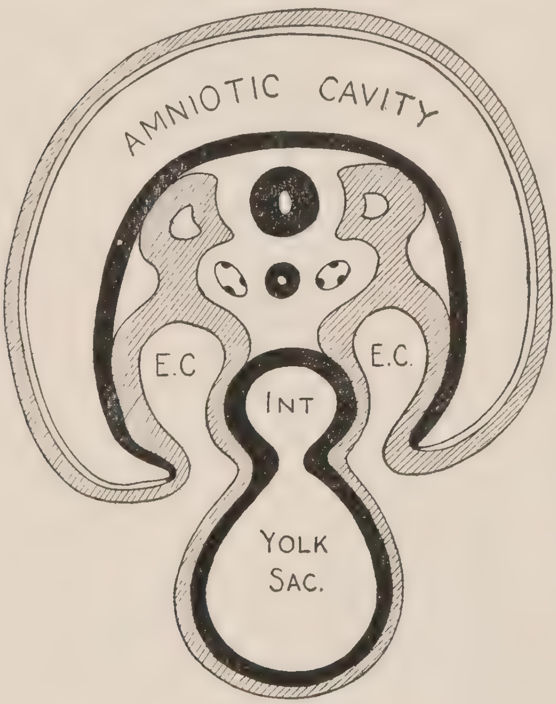


FIG. 15.

The median and lateral portions of the mesoderm are connected by a mass of cells, the intermediate cell mass. Soon after the median and lateral portions of the mesoderm have been differentiated, the median portion becomes divided transversely into a series of masses (mesodermic somites) (Fig. 14) corresponding to the future vertebræ. The lateral portions of the mesoderm do *not* undergo the above-mentioned transverse division into segments. Their splanchnic layer goes to form the visceral layers of the pericardium, pleuræ and peritoneum, while their somatic layer lies in contact with the body wall forming the parietal pericardium, pleuræ and peritoneum. The median portion of mesoderm forms the bones and muscles of the back and sends processes laterally between the somatic layer of the lateral mesoderm and the ectoderm to form the ventral muscles, etc.

In the preceding paragraphs development is described as if the embryo were a flat, pan-cake-like structure consisting of three (later four) layers of cells and for a part of the time taken up by the changes described, this is true. Very early, however, the edges of the pan-cake (embryonic disc) consisting of ectoderm above and endoderm below

turn downward and inward until they come close together forming a cavity lined with endoderm which is continuous with the endoderm lining the much enlarged blastodermic vesicle. As time passes the curled-in edges of the embryonic disc unite in the middle line; their line of fusion being shown in the linea alba of later life, the umbilicus marking the spot where the last communication persists between the interior of the embryo and its external coverings until it is divided at birth. The part of the endoderm which is now situated inside the embryo forms the primitive intestine. It has as yet no opening other than that communicating with the yolk sac. The yolk sac consists of the endodermic lining of the blastodermic vesicle which has become much separated from the original wall of the vesicle and covered with mesoderm. The space between the yolk sac and the wall of the blastodermic vesicle is called the extraembryonic cœlom.

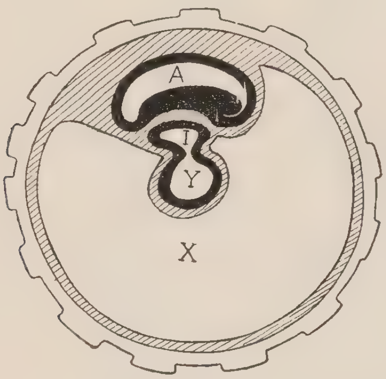


FIG. 16.

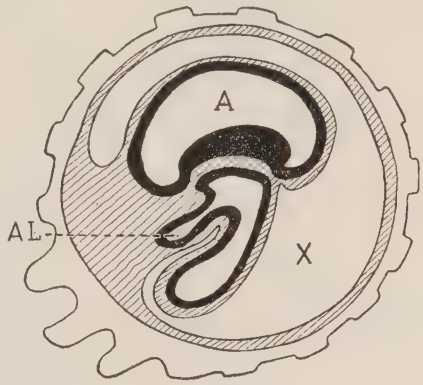


FIG. 17.

A, Amniotic cavity; *Y*, yolk sac; *X*, extraembryonic cœlom; *AL*, allantois.

Figure 15 shows in diagrammatic fashion a transverse section near the middle of the embryo at the stage of development which has been described.

No account has yet been taken of the formation of structures which surround, protect and nourish the embryo while in the uterus. The trophoblast of the enlarging vesicle becomes thickened and is in direct contact with the mucous membrane of the uterus in which it lies. Processes grow outward from the trophoblast and penetrate the uterine mucosa. Fig. 16 shows diagrammatically a longitudinal section of the embryo lying beneath the amniotic cavity. The mesoderm has spread out from its original position between the ecto and endoderm and has covered not only the yolk sac but has formed a lining to the whole vesicle and penetrated between the amniotic cavity and the trophoblast. A process of the extraembryonic cœlom pushes its way into the mesodermic tissue lying between the amniotic sac and the trophoblast (now named chorion) (Fig. 17) while the amniotic sac enlarges until it

covers the embryo completely except for that part of its under surface where the primitive intestine communicates with the yolk sac and a stalk of mesoderm (body-stalk) passes out to join the lining of the chorion (Fig. 18). Thus the embryo is now practically enveloped by two sacs, the amniotic sac next to it and the extraembryonic cœlom next to the chorion. As mentioned previously, processes scattered all over the trophoblast or chorion penetrate the uterine mucosa. These increase greatly in size and into them mesoderm penetrates and a very close connection is formed between the mesoderm of the embryo and the maternal uterine mucosa. These two structures being sepa-

Fig. 18.

rated by the trophoblastic epithelium. Ultimately many of the villi degenerate but those opposite the body-stalk persist (placental villi).

The chorion and body-stalk at their junction form the placenta; the rest of the body-stalk forms the basis of the umbilical cord. From the primitive intestine (hind-gut) at its caudal end there grows off a long slender tube which pushes its way into the body-stalk (Fig. 17). This is named the allantois. In man the portion of the allantois which lies in the body-stalk outside the embryo proper, is insignificant; the portion which lies inside the embryo forms the urinary bladder and the urachus, a fibrous cord running from the dome of the bladder to the

umbilicus represents, in the adult, the unused portion of the allantois. Not infrequently the unused portion of the allantois retains to a greater or less extent its tubular character and thus a fistula, lined with

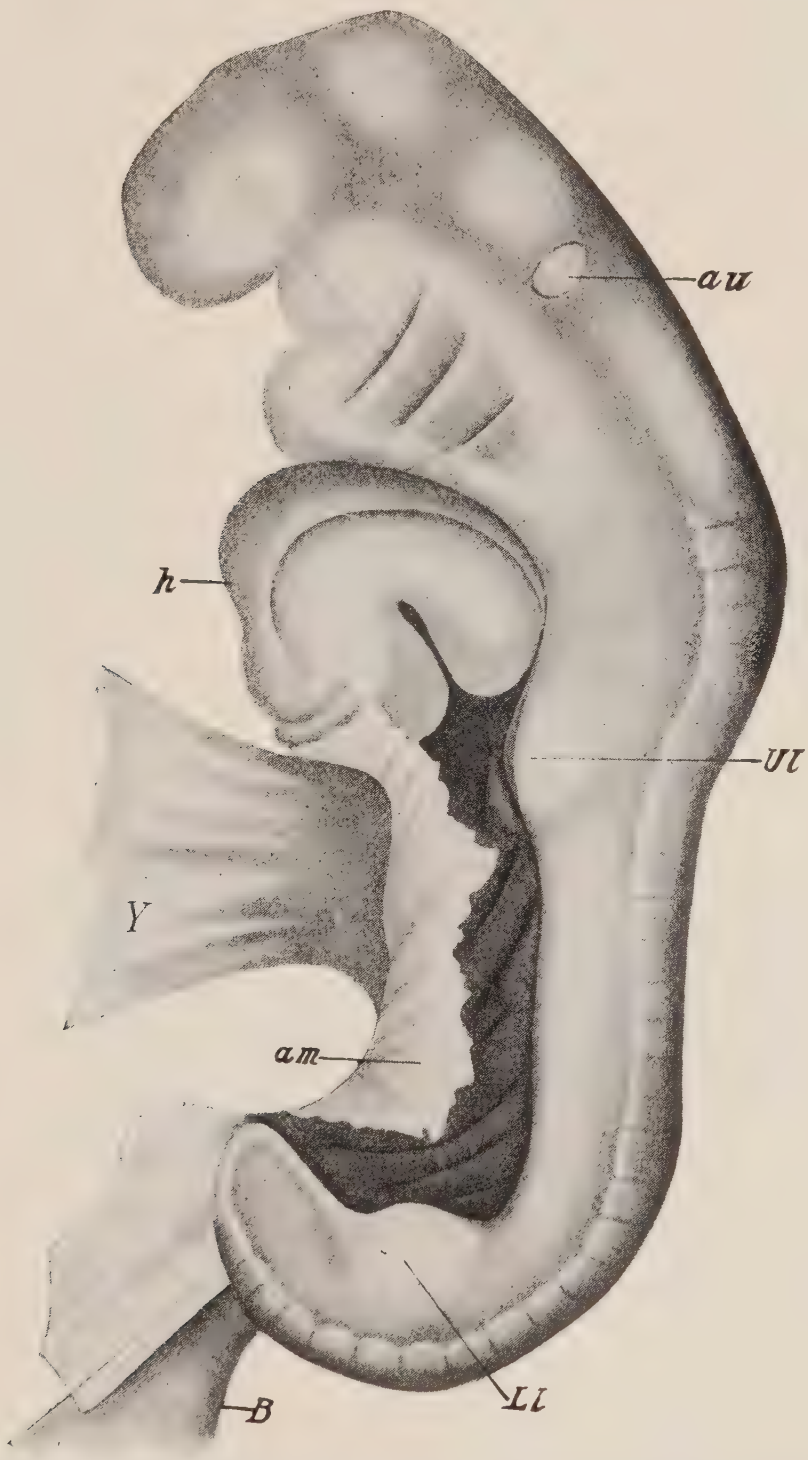


FIG. 19.—Embryo Lr, 4.2 mm. long. *am*, Amnion; *au*, auditory capsule; *B*, belly-stalk; *h*, heart; *Ll*, lower, and *Ul*, upper limb; *Y*, yolk-sac. (*His.*)

mucous membrane, may extend from the umbilicus to the bladder or, when the persistence is less complete, the allantois may form a diverticulum extending from the bladder, or a cyst along the course of the urachus.

As development proceeds, blood-vessels form in the embryonic mesoderm. Some of these send prolongations through the mesoderm of the body-stalk (allantoic vessels) into the placental villi. Thus are formed the vessels of the umbilical cord. The obliterated hypogastric arteries forming cords across the lateral walls of the urinary bladder and up the abdominal wall to the umbilicus remain in the adult mute witnesses to the earlier circulation.

Very early in development, even while the embryo is still flat and plate-like the head and tail ends are differentiated by constrictions from the body portion of the embryo. This differentiation becomes much more marked when the embryo assumes a somewhat cylindrical shape in the manner already described. The head and tail ends become ventrally flexed on the body, the anterior point of flexure being the cephalic flexure which corresponds to the position of the middle of three expansions at the anterior end of the medullary tube forming the anterior, middle and posterior brain vesicles (Fig. 19).

About the thirteenth day a depression appears immediately below the anterior cerebral vesicle. The depression deepens until it is separated from the primitive gut merely by a thin layer of ectoderm and a thin layer of endoderm (pharyngeal membrane), there being at this place no mesoderm present. The depression is the primitive oral cavity or stomodœum.

Soon the pharyngeal membrane disappears and the oral cavity opens into the anterior end of the primitive gut now called the primitive pharynx.

By the third week of development a series of arches separated by grooves (Fig. 19) appear on each side of the head end of the embryo. The arches are formed of mesodermic rods; between the rods the mesoderm is absent and thus grooves or clefts are formed both on the pharyngeal and external surfaces. In mammals the pharyngeal grooves are separated from the external grooves by a membrane consisting of both endo and ectoderm. In fish this membrane is absent and the clefts persist as the gills by means of which the blood of the fish is oxygenated.

In a four weeks' embryo exhibited by F. P. Johnson there were three distinct arches with the beginning of a fourth. Ultimately in the human embryo four clefts and five arches develop on each side of the body, the last arch lying posteriorly to the fourth cleft and not being very sharply defined along its posterior margin (McMurrich).

The fifth branchial arch in man is entirely rudimentary. The

second branchial arch in lower animals, *e.g.*, fish, is cartilaginous, but in man it becomes fibrous except at both extremities; its upper end becomes the styloid process of the temporal bone, its lower end becomes the lesser horn of the hyoid bone while its intermediate and major portion forms the stylo-hyoid ligament. The same arch forms the anterior pillars of the fauces which in the adult constitute the dividing line between the oral cavity and the pharynx.

The third arch gives rise to the body and greater horn of the hyoid and to the posterior pillars of the fauces

The fourth and fifth arches partake in the formation of the thyroid cartilage.

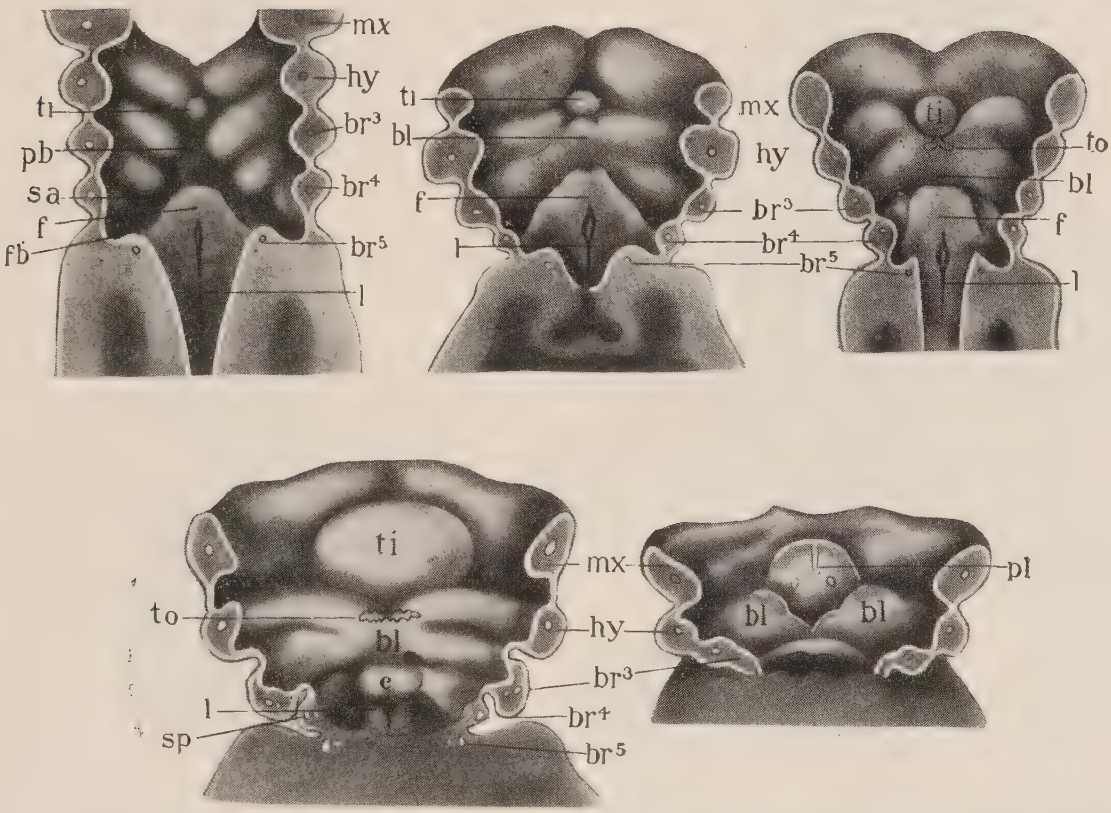


FIG. 20.—Five successive stages in the development of the anterior wall of the bucco-pharynx, showing the formation of the tongue, the thyroid gland and the epiglottis. *mx*, Maxillary arch; *hy*, hyoid arch; br^3, br^4, br^5, the three last branchial arches; *pb*, floor of the mouth; *ti*, tuberculum impar; *bl*, base of tongue formed by the fusion of the median ends of the 2d and 3d arches; *f*, furcula; rudiment of the epiglottis, the arytenoid cartilages and the ary-epiglottic folds; *e*, epiglottis; *l*, laryngeal orifice. (*Poirier and Charpey, after His.*)

During development the second, third and fourth arches of one side become united in the middle line with the corresponding arches on the other side to form the floor of the mouth.

In the middle line on the oral surface of the first and second arches a prominence forms (tuberculum impar) from which is developed the *anterior* portion of the tongue (Fig. 20). On the pharyngeal surface of the fused second and third arches there appear two prominences

close together immediately behind the *tubercular impar;* these form the base of the tongue. The whole tongue thus results from the union of three masses of tissue. When three masses of any material are placed in contact each with both of the others there is one point where contact is often imperfect. This is true in the case of the tongue and the result is a tube or canal, lined with endoderm, passing through the thickness of the tongue. Normally this canal becomes

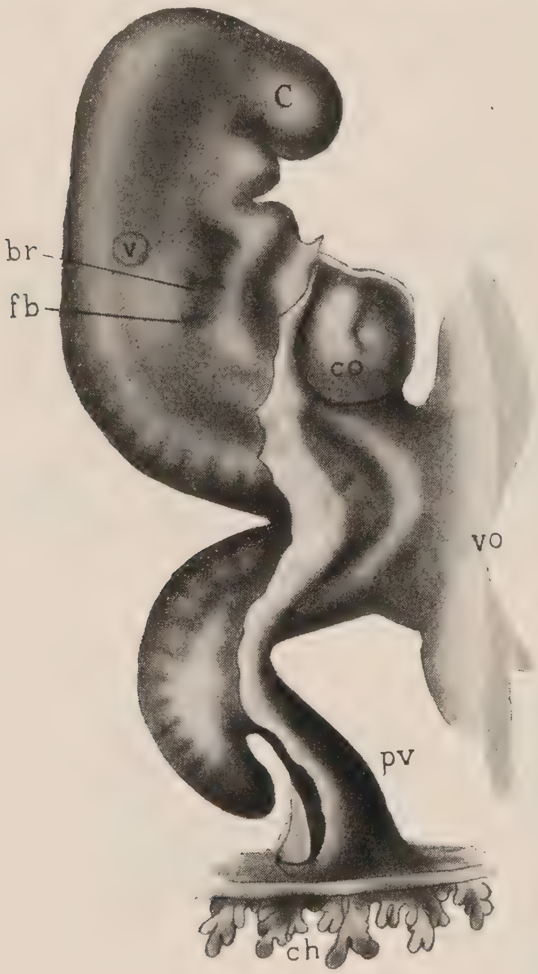


FIG. 21.

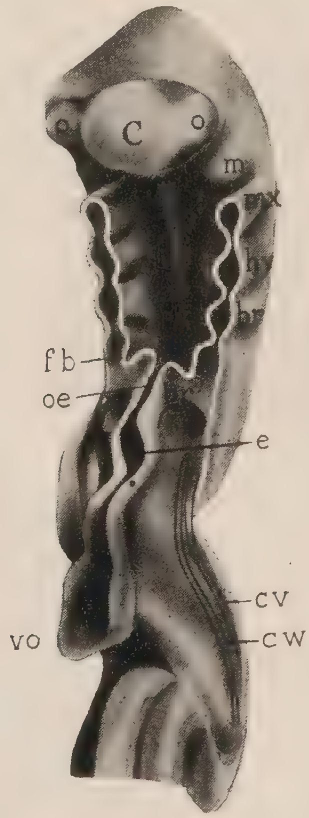


FIG. 22.

FIG. 21.—Profile human embryo, third week. *br*, Branchial arches; *fb*, branchial clefts; c, anterior cerebral vesicle; *v*, auditory vesicle; *co*, heart; *pv*, ventral pedicle; *vo*, umbilical vesicle; *ch*, chorion. (*Poirier and Charpey, after His.*)

FIG. 22.—Human embryo, third week. Opened anteriorly. *m*, Sup. maxilla; *mx*, inf. maxilla (1st arch); *hy*, hyoid arch; br^3, br^4, br^5, third, fourth and fifth arches; *fb*, sub-branchial fossa; *ph*, pharynx continuous with *oe* œsophagus, *e* stomach and with a short segment of intestine which passes through the open umbilical pedicle into the umbilical or vitelline vesicle; *c*, anterior cerebral vesicle with the two ocular vesicles *o*; *cv*, cardinal vein; *cw*, Wolffian canal. (*Poirier and Charpey, after His.*)

obliterated except at its superior end where the foramen cæcum persists as a reminder of its existence. The endoderm of the lower end of the canal provides material for the median portion of the thyroid gland. Persistence of the canal (thyreo-glossal duct) gives rise to various tumors and fistulæ. The line of union between the tuberculum impar and the other two masses of tissue is indicated in later life by a V-shaped mark on the tongue, the foramen cæcum being at the apex of the V.

Behind the origins of the base of the tongue on the inner surface of the anterior wall of the pharynx an elongated elevation appears (the furcula) in the middle line of which there forms a split or crevasse (Fig. 20). The anterior end of the furcula forms the epiglottis; the split or crevasse extends posteriorly into the future trachea. From the furcula there also are formed the arytenoid, the ary-epiglotidean folds, etc. As Prenant writes, "thus the orifice of the larynx becomes surrounded by a horseshoe-shaped ridge, thickened anteriorly and at its posterior extremities and projecting prominently into the pharyngeal cavity. This ridge is, in turn, surrounded by an arciform gutter (Fig. 20) of which the two extremities are deep (subbranchial fossæ); by means of this gutter the borders of the laryngeal cleft are separated from the anterior wall of the pharynx."

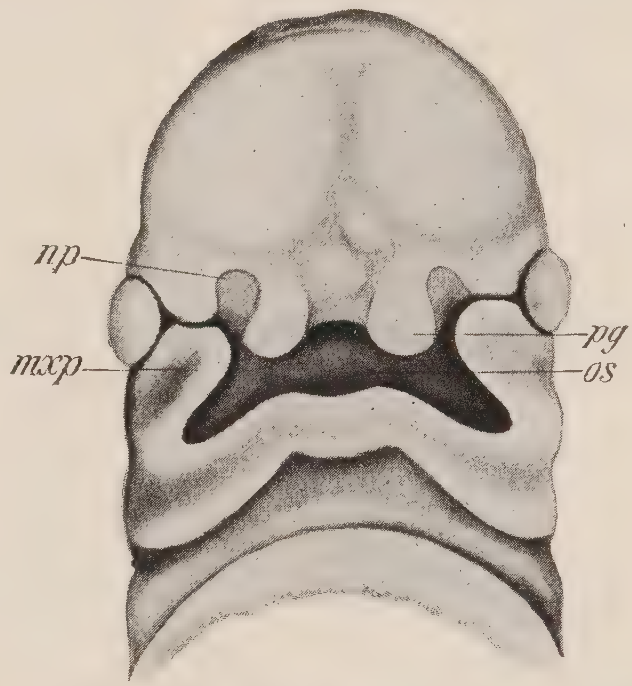


FIG. 23.—Face of embryo of 8 mm. *mxp*, Maxillary process; *np*, nasal pit; *os*, oral fossa; *pg*, processus globularis. (*His.*)

When first formed th e branchial arches are in series one behind the other (Figs. 21 and 22), one being exposed almost as completely as another; soon however the upper or anterior arches slide downward over the lower ones pushing these inward and in part covering them (Fig. 20) until the fourth and third branchial clefts are hidden in an irregular cavity lying between the walls of the neck (branchial arches) and the thoracic wall. His named this cavity the *precervical sinus*. The entrance to the sinus is bounded above (or anteriorly) by the second or hyoid arch which develops a small process backward (or downward) covering the sinus and corresponding to the *operculum* of fish. (The shark and dogfish have no operculum.) The opercular process at last fuses with the lateral wall of the body and the sinus becomes closed. Persistence of the sinus gives rise to various fistulæ and tumors.

As already mentioned, the branchial clefts persist in such creatures as fish and perform most important functions; in man, however, they normally *apparently* disappear. Their total disappearance is, however, more apparent than real, as they provide the material for the de-

velopment of various organs. The third pharyngeal clefts provide the endoderm from which the thymus gland is formed; the fourth pharyngeal clefts provide the material for the lateral lobes of the thyroid gland.

The first branchial arch (mandibular arch) requires very special study because from it in conjunction with a median process arising from the anterior end of the embryo, are developed the face, jaws, palate, etc.

The first branchial arch of one side unites with that of the other side to form the lower jaw and lip (Fig. 23). From the upper or anterior surface of the first arch on each side there arises a process (superior maxillary process) which grows inward toward the median line but does not meet its fellow of the opposite side, being separated from it by a process coming down from the median part of the extreme cephalic end of the embryo (fronto-nasal process). Very early in development the fronto-nasal process consists of a thickening of the ectoderm. In this on each side there forms a pit—olfactory or nasal pit. The edges of these pits become much raised and prominent except at the lower or oral part of their circumference. Soon the pits become converted into deep grooves running downward to join the cleft existing above the superior maxillary process. As the two edges of each olfactory pit or furrow become more prominent they form the external and the internal nasal processes. The two inner nasal processes become fused and form the most prominent parts of the nose as well as its columella and the lunula of the upper lip. The external nasal processes form the sides and the alæ of the nose.

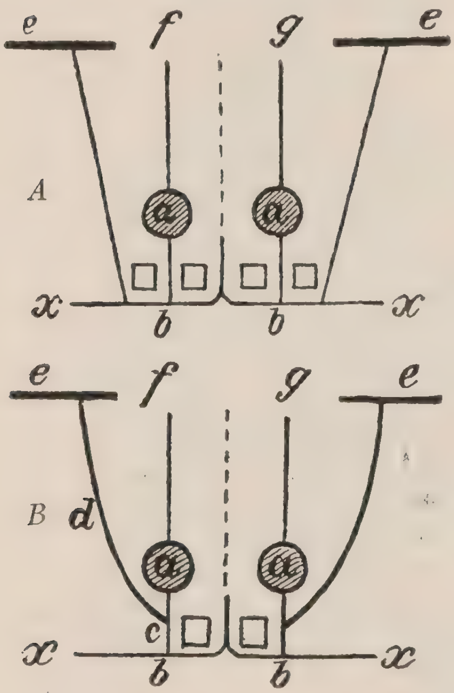
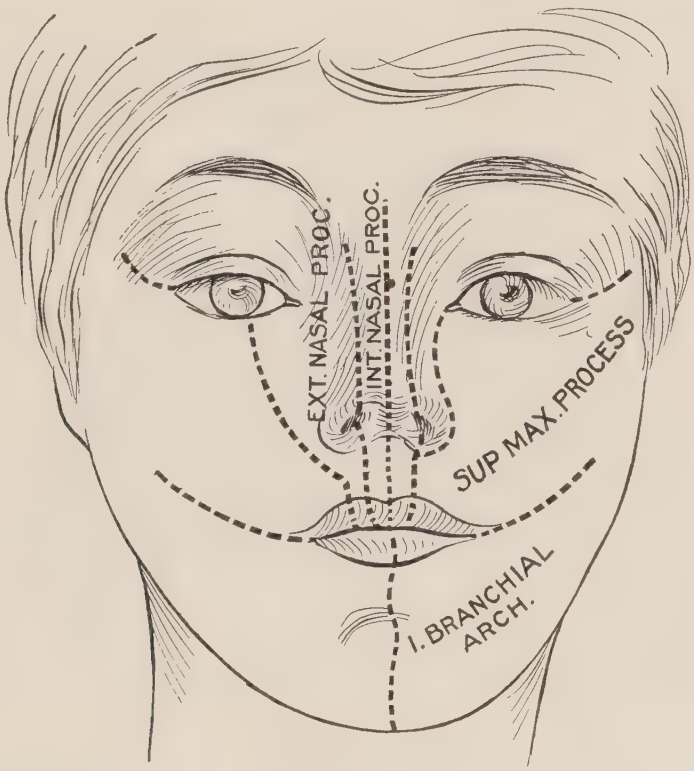


FIG. 24.—*a*, *a*, Nares; *e*, *e*, lower eye lids; *fb*, *gb*, fissures between the internal and external nasal processes; *x*, *x*, margin of upper lip; *fbe*, external nasal process according to Albrecht; *fcde*, external nasal process according to Trendelenburg. (*Trendelenburg.*)

Albrecht considers that the external nasal process extends downward to the mouth (Fig. 24, *A*) to form a segment of the upper lip external, to the lunula. Trendelenburg believes that the external nasal process, while it contributes to the formation of the lip external to the lunula does not reach the lip margin (Fig. 24, *B*). The views of Albrecht and Trendelenburg are important as explaining the incidence of various malformations (Fig. 25).

The fissures or spaces existing between the external nasal and the superior maxillary processes on each side are known as the naso-lachrymal or lachrymal grooves. At or just above the upper end of the lachrymal grooves the optic vesicles have already formed and from them the retinæ of the eyes are developed.

An epithelial cord sequestrated in the depth of each lachrymal groove gives rise to the lachrymal ducts leading from the eyes to the nasal cavity. The superior maxillary process of each side unites with the fronto-nasal process to form the cheek and upper lip—the lunula or groove in the middle of the upper lip remaining as a representative of the fronto-nasal process. As these superficial changes are occurring deeper changes may be observed taking place. The deeper part of the



Albrecht's view. FIG. 25. Trendelenburg's view.

fronto-nasal process becomes very thin and forms the anterior portion of the septum of the nose, the posterior portion of which is separately developed from another process arising from the skull (ethmoidal plate). The deeper part of the fronto-nasal process corresponding to that portion between the two olfactory pits (internal nasal processes) forms the intermaxillary or premaxillary bone in which the incisor teeth are developed (sometimes called *os incisivum*).

From each superior maxillary process horizontal projections or plates grow toward the median line (palatal plates or processes) to join with the corresponding parts of the fronto-nasal process and form a division between the oral and nasal cavities (Fig. 26). Thus the

palate is formed by the junction of the palatal processes of the superior maxillary processes with the nasal septum and with the intermaxillary bone, the intermaxillary bone itself being the result of the fusion of the deeper parts of the two internal nasal processes.

Albrecht, noting that the intermaxillary bone has two foci of ossification on each side, argues that it is developed from a corresponding number of processes, *i.e.*, that the external nasal process is also providing material for the development of this bone. Warinski's researches are generally believed to dispose of the Albrecht theory, but to the author it is strongly supported by the fact that fissures or clefts due to non-closure of the lachrymal fissure do not necessarily follow the line marked out by that common deformity, hare-lip. The cleft may extend from the middle of the lower eyelid downward, well external to the ala of the nose, and involve the upper lip external to the lunula.

FIG. 26.—View of the roof of the oral fossa of embryo showing the lip-groove and the formation of the palate. (*His.*)

In man the intermaxillary bone, early in intra-uterine life, becomes united to the superior maxillary process; in the lower apes, the carnivora, etc., this bone retains its independence and assumes a position well in front of the palate. In such animals the bone is frequently known as the premaxillary bone. In certain cases of complete cleft palate the intermaxillary bone, not having united to the maxillæ, is carried forward by the growth of the nose until it assumes a position roughly analogous to that seen in the animals referred to above.

Just above the first branchial cleft there early appears a thickening of the ectoderm. This thickening soon sinks into the embryo and becomes a pit. The mouth of the pit quickly becomes narrow and at last disappears, leaving a vesicle lined with ectoderm inside the embryo. This is the auditory vesicle or otocyst and it soon becomes con-

nected with the central nervous system by the acoustic nerve. The auditory vesicle provides the ectoderm out of which develop the essential organs of hearing and of equilibrium, viz., the internal ear. The middle and external ears are merely accessory organs of hearing and have a different origin.

The external ear is developed from the ectodermic portion of the first branchial cleft and the first and second arches. The middle ear is developed from the visceral side, *i.e.*, the endodermic side of the same structures. The middle is separated from the external ear by the membranum tympani, which is formed from the occluding membrane of the first cleft (ectoderm externally and endoderm internally) and partly from the first and second arches.

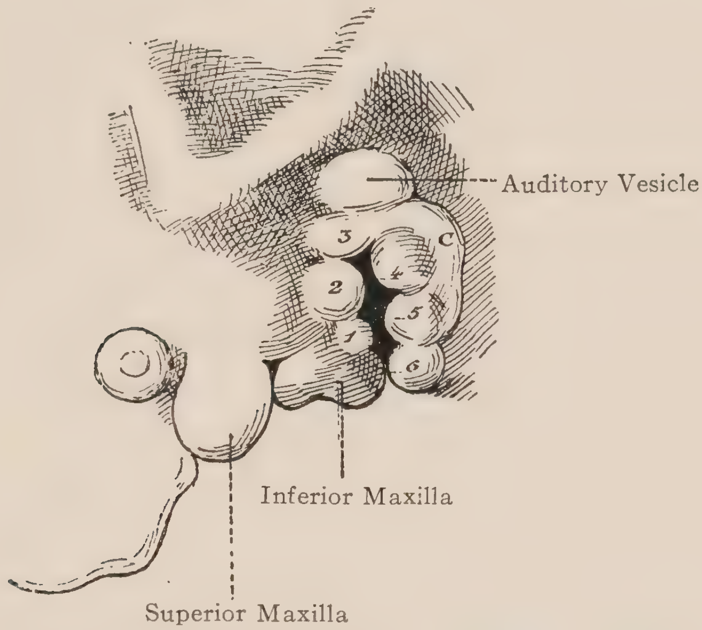


FIG. 27.—Embryo (11 mm.). (*His.*) 1–2–3–4–5 Auricular tubercles; *c*, hyoidean helix.

Around the first cleft six tubercles appear, three arising from the first arch and three from the second. His distinguishes these tubercles by the numerals 1, 2, 3, etc. Behind the three tubercles arising from the second arch a fold of skin forms (C, Fig. 27), entirely independent of the tubercles; this has been named the hyoidean helix.

It is believed that tubercle 1 forms the tragus; 2 and 3 contribute to form the helix; 4 the antehelix; while the hyoidean helix forms the lobule and a large part of the helix. Schwalbe thinks that another fold of skin (mandibular helix) also aids in forming the helix.

Guibé writes: "At the beginning of the third month, the posterior and superior part of the pinna begins to separate from the head. Toward the middle of pregnancy union between the tubercles has terminated; all the definite parts of the ear are recognisable except the

concha which develops later." The formation of an operculum which covers all the gills in fish and the absence of this large operculum in sharks have been already noted. Bland-Sutton points out that in sharks a fold of skin is formed from the branchial arch in front of each fissure, and so an operculum is formed for each fissure or gill cleft. "In mammalian embryos a slight prominence or tubercle is for a time visible anterior to each of these clefts. In most cases the tubercles disappear from the posterior bars, but those in relation with the anterior cleft enlarge and are joined by accessory tubercles to form the pinna. Thus embryology has taught me to regard the pinna as consisting mainly of an operculum which has become modified for acoustic purposes" (Bland-Sutton). Recognition of the presence of temporary opercula on all the branchial arches explains the occasional occurrence of cervical auricles in man. Failure of coalescence between the units which form the ear explains the occurrence of various congenital fistulæ and tumors of the ear, while an excess in the number of the primary tubercles can account for the occurrence of accessory lobes to the ear. The growth of the external ear, as described above, separates the dorsal portion (angular fossa) from the rest of the first branchial cleft. This angular fossa becomes divided into two parts: one remaining shallow constitutes the concha, while the other becoming deep gives rise to the external auditory meatus.

The edges of the first branchial cleft on its visceral or endodermic side coalesce and so convert the cleft into a canal which ultimately forms the tympanic cavity and the Eustachian tube. The walls of the tube are, of course, formed by the first and second branchial arches and from them are developed the ossicles with their muscles. From the first arch arise the malleus and incus; from the second arch arises the ring of the stapes (the plate of this ossicle is developed from the fundament of the internal ear).

At first the ossicles lie imbedded in soft gelatinous tissue outside the tympanic cavity which is a narrow fissure, but, after birth, air passing up the Eustachian tube enlarges the cavity and presses its endodermic lining (mucous membrane) over and between the ossicles until, the gelatinous tissue having shrunk, the ossicles become apparently free in the tympanic cavity. This freedom is only apparent as the ossicles are enclosed in folds of mucous membrane and thus attached to the walls of the tympanum in similar fashion to that by which the small intestine is attached to the abdominal wall.

During the second month of intra-uterine life the eyelids are formed.

The lower lid is formed as a fold from the skin of the superior maxillary process, while the upper is formed from a fold of skin which unites the superior maxillary process to the frontal process. The inner angle of both lids arises from the external extremity of the primitive frontal process. As the lids grow, their edges meet at about the third month and become fused together. This fusion is only epithelial and during its existence the Meibomian glands and the eyelashes form. A few days prior to birth the eyelids in man separate, while in many animals, *e.g.*, dogs, the fusion persists for some days after birth.

The Meibomian glands are formed from the *rete* Malpighii, the cells of which proliferate and penetrate the eyelid as solid rods which later become tubules. On the median side of the eye in many animals, *e.g.*, birds, a third lid is formed under the others and is named the *membrana nictitans*. In man this third lid exists merely as a rudiment —the plica similunaris—and a number of small glands which are developed in it produce a reddish nodule, the *caruncula lachrymalis*. The ocular surface of the eyelids gives rise to the conjunctival sac and from the outer and upper recess of this sac epithelium penetrates the deeper tissues, upward, and forms solid branched rods which later become hollow and form the lachrymal gland.

From the inner angle of the eye a cleft bounded by the frontal process above and the superior maxillary process below leads from the eye to the oro-nasal cavity—the lachrymal fissure. In the bottom of this fissure a solid rod of epithelium forms and becomes buried in the mesoderm. This rod becomes hollowed out into a tube long after it has been entirely separated from its ectodermic origin and constitutes the lachrymal duct. At first the lachrymal duct is separated from the nasal cavity, but shortly before birth (sometimes even after birth) the duct becomes patent the whole distance between the eye and the nose. The lachrymal fissure itself becomes completely obliterated.

SECTION V

HARE-LIP AND CLEFT PALATE

By

JOHN FAIRBAIRN BINNIE, A. M., C. M., F. A. C. S.

Hare-lip is due to a want of union between the superior maxillary process of one side and the fronto-nasal process. Most authorities believe this failure of union to be between the superior maxillary and the central part of the fronto-nasal processes. Albrecht thinks that hare-lip is occasioned by a failure of union between the lateral portion of the fronto-nasal process which, in his opinion, takes part in the formation of the normal upper lip, and the central portion of the same process (Fig. 25).

The cleft in the lip may be partial or complete. When complete, the cleft extends from the margin of the lip into the nostril, and the corresponding ala of the nose, having lost its anchorage to the middle line, is usually displaced laterally and adds considerably to the deformity. Partial hare-lip varies from a mere notching of the lip margin to a cleft which almost invades the nostril. When the superior maxillary processes of both sides fail to unite with the fronto-nasal process, double hare-lip results. The clefts in double hare-lip may be partial or complete, or one may be partial and the other complete. When both clefts are complete, the portion of tissue between them (the lunula) is generally atrophied or distorted. Hare-lip is very frequently accompanied by cleft palate.

Some rare cases of hare-lip have been reported in which a cleft exists involving the lip margin and from the cleft to the nostril there extends a groove the floor of which consists of skin and mucous membrane without any muscle; in other cases of apparently complete hare-lip a narrow bridge of tissue may span the cleft about its middle. These peculiar conditions have been attributed to intra-uterine healing, but they are really examples of partial hare-lip.

Cleft Palate.—The palate is formed by the union of the palatal processes of the superior maxillary process with the septum of the nose and the intermaxillary bone (these two arising from the fronto-nasal process). If the union between these structures fails to be accom-

plished, the result is a cleft palate which may be single or double, complete or incomplete.

In single, complete cleft palate there is a cleft between the superior maxillary process of one side and the bony and cartilaginous derivations of the fronto-nasal process. (According to Albrecht's theory, the anterior portion of the cleft runs between the lateral and central segments of the intermaxillary bone or the lateral segment of that bone is absent.) In double, complete cleft palate there is no union between the various components of the palate, the result being a double cleft through the alveolus and a single cleft through the rest of the palate. When the union between the elements forming the palate is only partial, then an incomplete cleft palate results. (Cleft alveolus; cleft alveolus and hard palate; cleft uvula; cleft soft palate; cleft of soft and hard palates; fistula in hard or soft palates.) (Figs. 28 and 29.) The fact that the various components of the palate are normally early united exercises a strong restraining influence on the growth of each component; in fact the palate grows and shapes itself as a whole. When union between these parts does not take place, this restraining influence is absent and each part grows independently and generally erratically. Thus in single cleft palate the septum does not remain in the middle line but is pulled over toward the side on which it is attached, while the palatal bone on the affected side is usually much more nearly vertical than normal. In complete double cleft palate the unattached intermaxillary bone is borne forward by the growth of the nasal septum until it lies well anterior to the normal line of the alveolus and occupies a position entirely analogous to the premaxillary bone of many animals (Figs. 29, 30 and 31). The lunula of the upper lip in such cases usually exists as a tag of skin on the top of the intermaxillary bone projecting forward from the point of the nose.

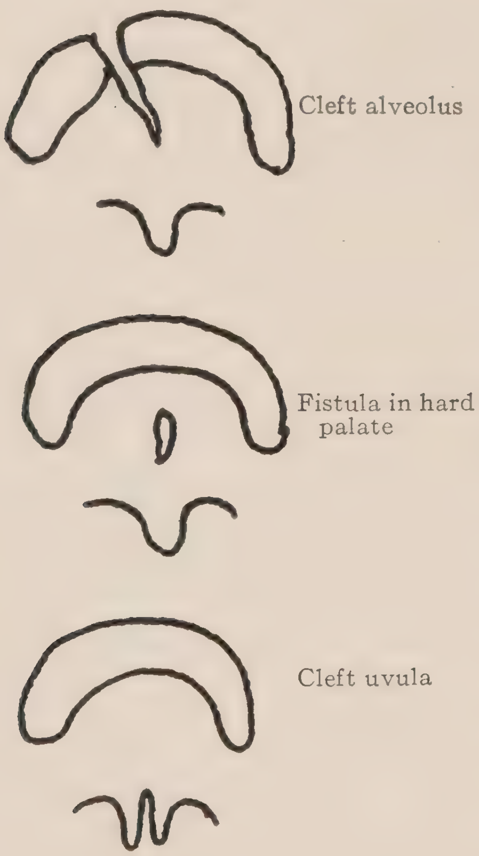


Fig. 28.

In single, complete cleft palate the alveolus which is attached to the intermaxillary bone usually grows out of alignment, protrudes forward and becomes unduly prominent. The etiology of hare-lip, cleft palate

and the various facial clefts and deformities discussed in the succeeding pages is very obscure. It is well known that such deformities are often hereditary, but yet there is very often no such history. The

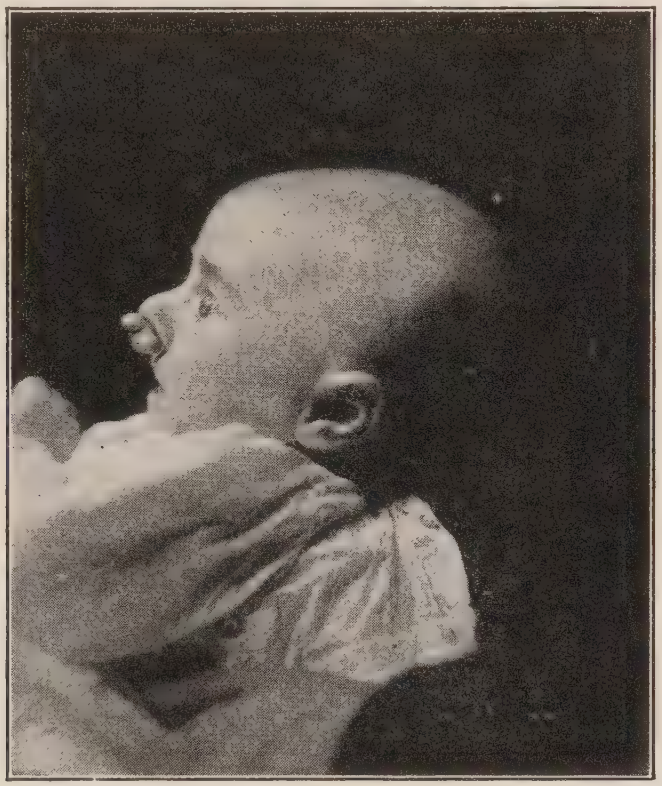


FIG. 29.

distressed mother frequently attributes the deformity to some "maternal impression" or to some accident sustained during the pregnancy. Amniotic adhesions have been blamed for their occurrence and *theoretically* may act in three ways:

FIG. 30.

FIG. 31.

1. The amniotic sac may be adherent to the sides of the branchial clefts and so prevent their normal closure.

2. The adhesions may be to the cheek of the embryo at a distance

from the cleft and act by preventing the superior maxillary process growing inward to come into contact with the fronto-nasal process.

3. An adhesion between any part of the embryo (*e.g.*, one of the limbs) and the sac may form a string and this string or band may cause such pressure on one-half of the face as to prevent growth in the direction necessary for fusion, or the band may actually lie in the embryonal cleft and so prevent closure.

Some authors have considered that the tags of skin and cartilage which constitute accessory auricles are really remnants of amniotic adhesions.

Many arguments *pro* and *con* have been advanced but nothing has been proved. (See F. König, Berl. Klin. Wochenschr., 1895, No. 34; E. Fronhöfer, Archiv für Klin. Chir., LII, p. 883; Th. Haymann, Archiv für Klin. Chir., LXX, p. 1033.)

Treatment of Hare-lip and Cleft Palate.—The only treatment for hare-lip and cleft palate is operation, but before undertaking operation it may be necessary to prepare the child by proper feeding and by the treatment of adenoids or any such lesions which may be present and might interfere with the healing.

Principles underlying all good operations for hare-lip:

1. Tension must be relieved, so that the function of the sutures is practically merely to *hint* to the edges of the cleft that they must stay in apposition.

2. The edges of the cleft must be freshened so that union can take place.

3. This freshening must be done in such a way that the edge of the upper lip opposite the line of suture is made to project below the normal level of the lip. The object of this is to avoid the occurrence of a notch on the lip after the wound has shrunk when healing is complete.

4. The freshened edges of the cleft must be brought together and kept together.

5. The red line of the lip must extend in a clean, unbroken curve from one side of the newly formed lip to the other.

6. The depth of the mucous membrane must be equal on each side of the line of suture.

7. The newly formed lip must not be too short, but must be lengthened so that it will more than cover the gums.

8. The nostril must be reproduced so as to have exactly the same dimensions as the sound nostril, and must consist of tissue of the same texture as the normal nostril.

9. There must be no flattening of the nose or ala nasi on the affected side.

Incomplete Single Hare-lip.—The cleft in the lip does not extend into the nostril; it is a mere notch. It may be unnecessary to relieve tension, though, when the cleft is at all wide, this is imperative and must be done thoroughly. Malgaigne's operation or Nélaton's (Figs. 32, 33, 34 and 35) are very good. When the ala of the nose is pulled to the side

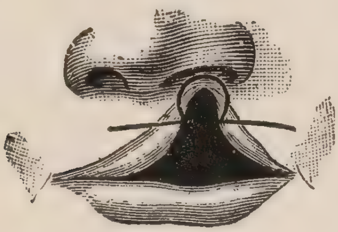


FIG. 32.

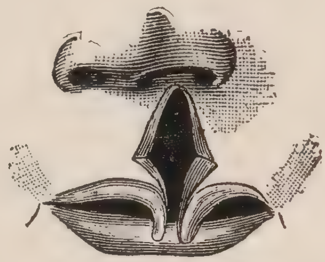


FIG. 33.

FIGS. 32 AND 33.—Malgaigne. (*Esmarch and Kowalzig.*)

FIG. 34.

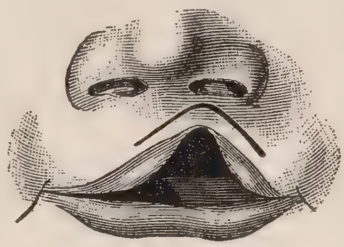


FIG. 35.

FIGS. 34 AND 35.—Nélaton. (*Esmarch and Kowalzig.*)

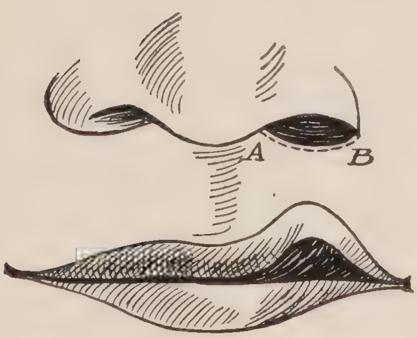


FIG. 36.

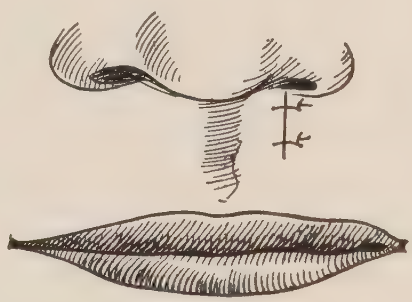


FIG. 37.

FIGS. 36 AND 37.—C. H. Mayo's operation.

and the nostril is much widened C. H. Mayo relieves tension very thoroughly, separating the ala of the nose from its deep connections; then he makes his denudation at the floor of the nostril (Fig. 36 A, B) and, by pulling the lip downward and introducing sutures, converts the horizontal wound AB into a vertical one (Fig. 37). The result is obliteration of the notch in the lip and correction of the deformed position of the ala of the nose.

Complete Single Hare-lip.—*Relief of Tension.*—This is one of the most important steps in all hare-lip operations. Failure to relieve tension completely is the most common cause of bad results. The upper lip is everted and pulled upward and outward by the finger and thumb of the left hand (Fig. 38). The mucous membrane is incised at its reflection from gum to lip, and divided from the premolar region on one side to the premolar region on the other side, if necessary. Through this incision, with knife or scissors, one separates the soft parts from the bones (keeping the instrument close to the bone). Particular attention must be paid to the separation of the ala of the nose from the bone (Fig. 39).

FIG. 38.—Relief of tension.

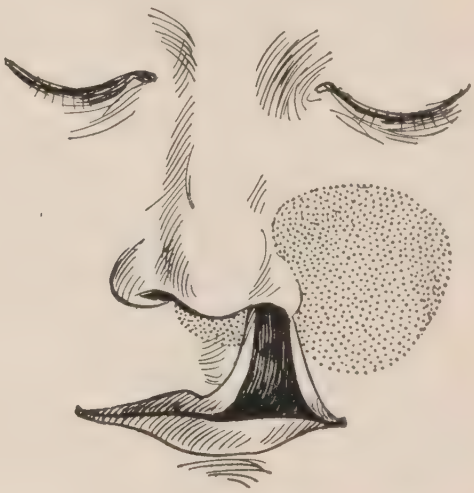


FIG. 39.
The dotted area represents the extent of dissection that is commonly required for the relief of tension.

To what extent must the soft parts be separated from the bone? The answer to the foregoing question is, until the edges of the cleft in the lip, when placed together, show a tendency to lie in apposition, so that the sutures when introduced may be tied without giving rise to tension.

Freshening the Edge of the Cleft.—The methods of doing this are legion.

J. E. Thompson's Methods.—To insure accuracy in making the incisions use sharp-pointed compasses which can be fixed by a screw and with them make all the necessary measurements and marks.

1. There is not much diversion of the sides of the cleft. At A and A′, Fig. 40 (1) a projection or shoulder shows the junction of the cleft and the nasal margin. With compasses measure the distance from Y (midway between A and A′) to Z placed on an imaginary line KL which represents the natural curve of the upper lip. Fix the compasses so that their points will remain this distance (YZ) apart. Place one

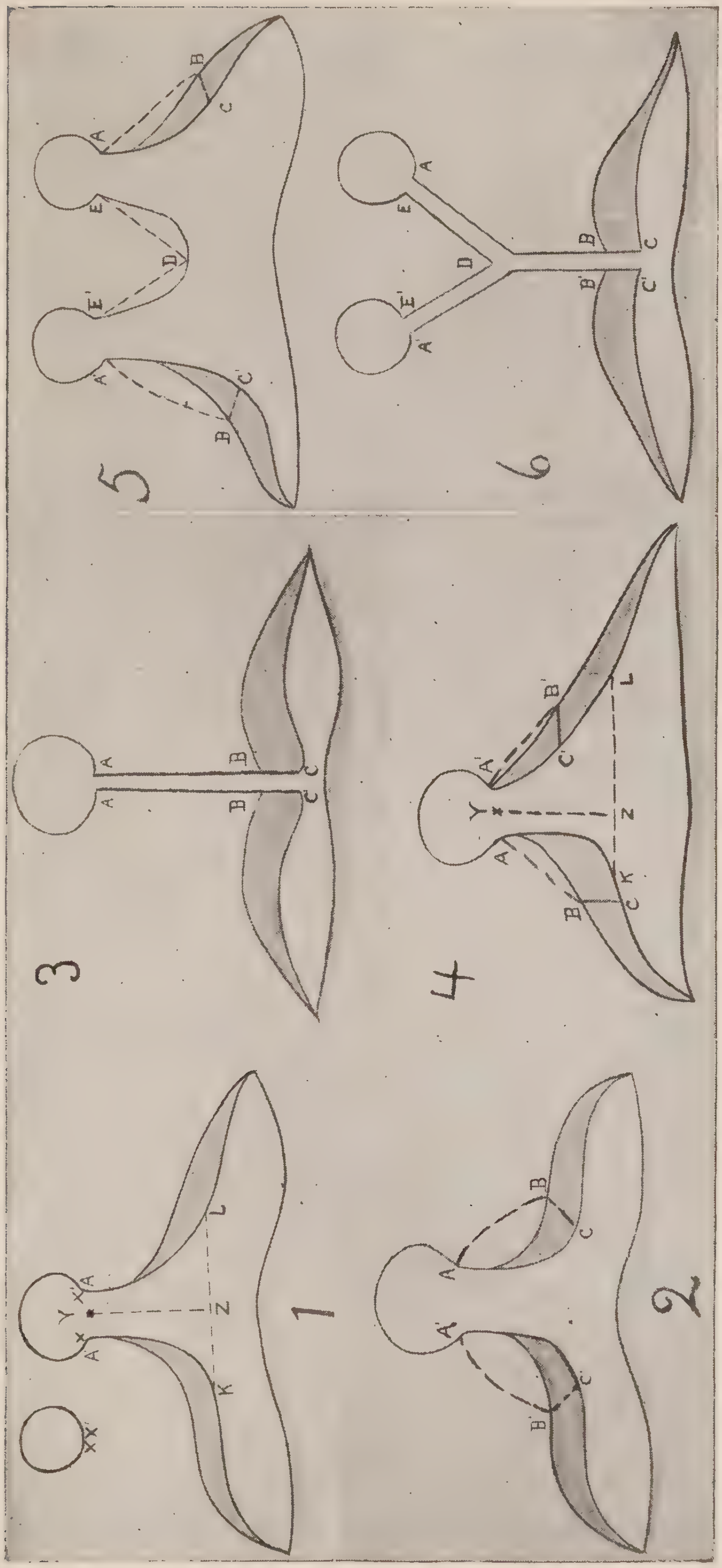


Fig. 40.—(*Thompson.*)

point of the compasses at A and the other at B on the skin of the lip close to the red line of the mucous membrane. Mark the point B, Fig. 40 (2) by pricking the skin. In the same fashion find and mark the point B′. The line AB equals in length the line A′B′. Readjust the compasses and take the measurement BC, the point C being on the free margin of the lip. The angle ABC is usually about 60° and must always be less than 90° if a projecting prolabium is to result from the completed operation. Mark the point C by pricking the mucosa. In the same fashion find and mark the point C′. The line BC equals in length the line B′C′. Pass a retaining stitch of horsehair "through each side of the mucous membrane of the lip close to, but below, C and C′." Suture A to A′, B to B′, C to C′ (Fig. 40 (3)).

2. The sides of the cleft are unsymmetrical. Fig. 40 (4) shows how the same operation gives the same results provided the cheeks have been well mobilized.

Double Uncomplicated Hare-lip.—The deformity is not complicated by the central portion or lunula of the lip being carried forward toward the tip of the nose by the intermaxillary bone.

J. E. Thompson's method (Surg. Gyn. Obst., May, 1912). In Fig. 40 (5) and (6) "the shoulders marking the margins of the nostrils are shown at A and E, and at A′ and E′. The triangle E′DE shows the line of incision by which the central piece of skin covering the intermaxillary bone is pared. E and E′ are placed on the inner margins of the nostrils. The sides DE and DE′ are usually equal in length to one another and their length varies according to the depth of the central piece of skin. It must never be greater than AB and is usually much less. The points A, B and C and A′, B′ and C′ are chosen as described previously in the operation on single hare-lip. Fig. 40 (6) shows the final appearance of the lip when the flaps have been cut and the parts approximated. The point A is in contact with E, A′ with E′; the apex D of the triangle E′DE lies somewhere along the line AB; the point B is in contact with B′, and C with C′.

Two essential points must be emphasized:

1. Under no circumstances must the circumference of the nostril be encroached upon.. The shoulders that represent the margins of the nostril must be accurately approximated.

2. The points B and B′ must be as close to the red line of the lip as possible, and must always be on the skin (upper) side of this line.

Complicated Hare-lip.—Single complete hare-lip. The alveolus is cleft and one side of the cleft is much more prominent than the other.

If possible push the protruding part into alignment with the rest of the alveolus. If this is not possible introduce a mattress suture of wire as shown in Fig. 41. Divide the alveolus at A, push the mobilized portion of bone into proper position and fasten it with the wire.

Complicated Double Hare-lip.—The intermaxillary bone is situated at the tip of the nose.

Some surgeons advise removal of the misplaced intermaxillary bone but this is entirely improper. It ought to be replaced in the alveolar cleft. Most of the methods of operating cause so much deformity of the nasal septum that the passages are seriously occluded and a "blunt and bull-dog" nose is formed. Reich has endeavored to overcome these errors.

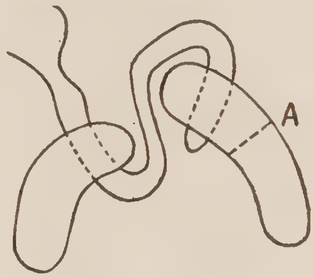


FIG. 41.

Reich's Operation.—*Step* 1.—Dissect the philtrum from the intermaxillary bone and, in doing so, expose the edge of the cartilaginous septum immediately above the intermaxillary bone. With straight scissors divide the nasal septum obliquely upward and backward as high as possible (Fig. 42). This cut divides the mucosa, periosteum and perichondrium, cartilaginous septum and the perpendicular plate of the ethmoid and leaves in front of it and separate from the rest of the septum, a plate of bone

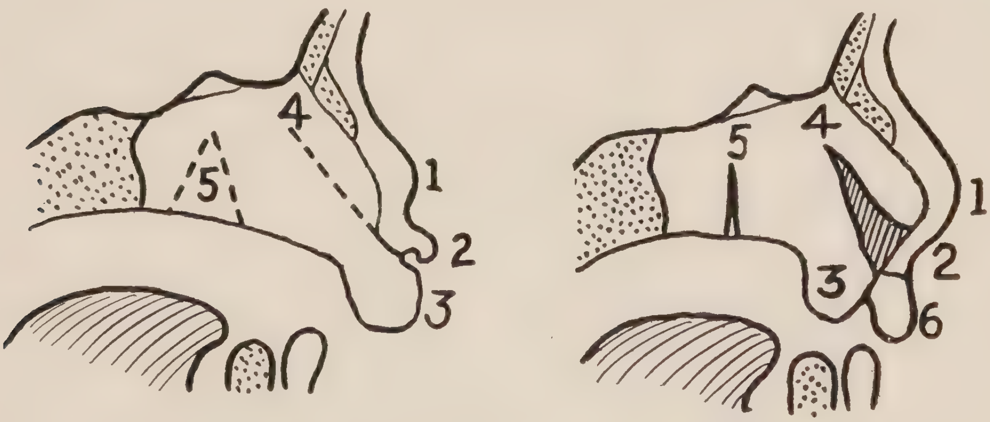


FIG. 42. FIG. 43.

FIGS. 42 AND 43.—1. Point of Nose. 2. Philtrum of nose. 3. Intermaxillary bone. 4. Oblique section of septum. 5. Wedge of septum removed.

and cartilage reaching from the root to the tip of the nose, guaranteeing its profile.

Step 2.—Make an incision about ¾ inch in length through the muco-periosteum of the posterior portion of the nasal septum. Pass a fine periosteal elevator through this incision and raise the muco-periosteum on each side of the septum. With strong scissors excise a tri-

angular piece of the septum. Push the intermaxillary bone into correct position.

Step 3.—Close the hare-lip in the usual manner, using the philtrum nasi to form the cutaneous septum of the nose (Fig. 43).

Sutures in Operations for Hare-lip.—One or two deep sutures involving almost the whole thickness of the lip must be inserted. The best material for these is silkworm-gut or waxed silk. Hare-lip pins have been discarded, as they cause too much scarring. Usually the deep sutures are inserted through the skin and give rise to considerable scarring at their points of entrance and emergence; a better plan is to introduce the *deep* sutures from the mucous surface and *not* to involve the skin in their bite; when this is done, these stitches must not be removed until healing is complete, when they will generally be found to have cut their own way out. If the surgeon endeavors to remove such sutures at the end of a week, he requires to evert the lip, and thus jeopardizes the line of union. Several superficial cutaneous sutures must be introduced; the best material for these is horsehair. Horsehair sutures, because of their elasticity, leave less scar than any others. All cutaneous sutures (superficial and deep) may be removed by the seventh day. It is wise to remove a few of the superficial sutures as early as the second day.

Dressings after Operations for Hare-lip.—Should tension on the sutures be feared, a strip of adhesive plaster may be placed from cheek to cheek across the upper lip, in such a way as to relieve tension. If, however, the soft parts of the lip and cheeks have been sufficiently separated from the bones at the beginning of the operation, such a measure is unnecessary and undesirable, as it simply irritates the already irritated patient. It is not necessary to apply any dressing to the wound, as nature soon seals it with dried blood-clot. Until the sutures are removed there should be as little interference with the wound as possible. If it is going to heal, it will heal under the scab, and the best intentioned endeavors to clean the wound will merely interfere with nature's work and do no good, as cleanliness can never be attained in such cases.

Care must be taken to so fix the little patient's arms that scratching of the wound is rendered impossible.

Treatment of Cleft Palate.—The best time to operate for cleft palate is before the eruption of the milk teeth.

Rose's or Trendelenburg's position is of much advantage in preventing blood from entering into the larynx and trachea.

For swabbing the mouth fragments of marine sponges are preferable to pledgets of gauze. A good light is essential. The anæsthetic ought to be administered by means of a vaporizer through a catheter-like tube so that continuous anæsthesia may be maintained without interfering with the operation.

Brophy's Operation.—Applicable in children younger than three months; generally possible, though not so easy, in children up to, but not beyond, the sixth month. The only special instruments required are two of Brophy's strong needles (Fig. 44); a few strands of No. 20 silver wire; lead plates No. 17, American gage. No special mouth-gag is necessary, the assistant's fingers being sufficient to keep the mouth open and the tongue depressed. During operation bleeding is easily controlled by pressure with sponges wrung out of hot water.

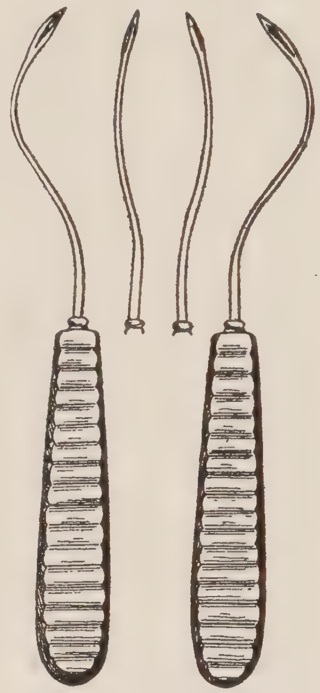


FIG. 44.—(*Brophy, "Dental Cosmos."*)

The Operation.—1. Anæsthetize the patient. Place in Rose's or Trendelenburg's position. Pass a stout thread through the anterior end of the tongue as a traction suture. This is a great convenience.

2. With a knife pare thoroughly the edges of the cleft in the hard palate, cutting away a little of the bone itself to insure thoroughness.

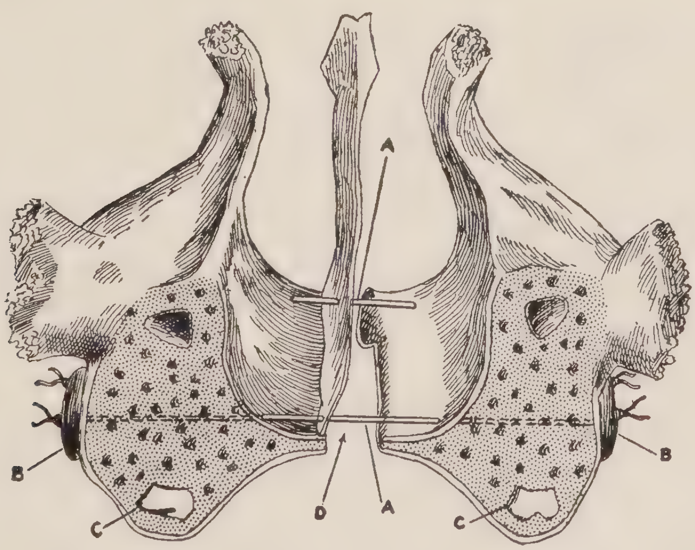


FIG. 45.—(*Brophy, "Dental Cosmos."*)

Either pare or horizontally split the edges of the cleft in the soft palate. If split thoroughly, the edges of the split retract and thus a good raw surface is left without any loss of tissue.

3. Thread a Brophy needle with strong silk. Raise the cheek and pass the threaded needle through the superior maxilla from without inward at a point just back of the malar process and high enough to be above the palate (Fig. 45). When the needle appears in the cleft, pick up the thread, which it carries, with hook or forceps. Withdraw the needle, leaving the loop of thread *in situ*. Catch the ends of the thread in a hemostat. Through a corresponding part of the opposite bone pass a loop of thread in the same manner. Pass this second loop of thread through the first and pull the latter out, carrying with it the former. We now have a loop of thread passing through both superior maxillary bones above the palate, and when necessary through the nasal septum. By means of this thread pull a strand of very strong silver wire through the same track.

4. In the same manner introduce one or sometimes two other silver wires through the anterior portion of the maxilla above the level of the palate.

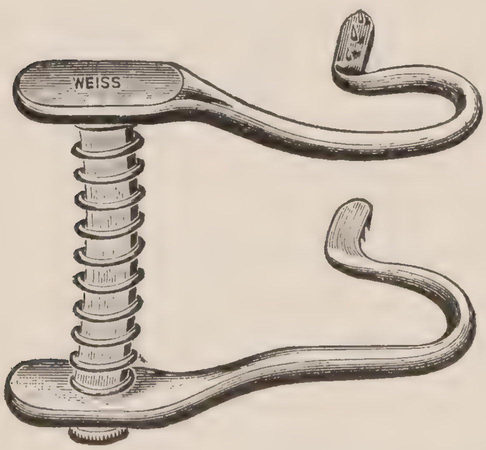


Fig. 46.—(*Lane.*)

5. Pass the ends of the silver wire through the holes in lead plates moulded to fit the convexity of the buccal surfaces of the bones (one plate on each side). Draw the wires tight and twist them together—*i.e.*, twist the "right end of the anterior wire to the right end of the posterior wire and do the same on the left side."

6. With the thumbs forcibly press the two maxillary bones together until the cleft is completely closed. Twist the wires once more so as to hold the bones firmly together.

7. Close the soft palate by sutures. The state of the patient may necessitate this step being delayed until another day. Do not close the hare-lip until the palate is completely closed and the patient has recovered.

Lane's Operation.—*Uranoplasty.*—For many reasons the operation should be performed as early as possible after birth. Before the milk teeth erupt there is plenty of material present to permit the closure of almost any defect no matter how wide it may be. The large surfaces of bare bone left after Lane's operation heal very rapidly.

Instruments required:

1. Lane's mouth gags with sharp teeth which bite into the gums. These are sold in pairs of proper sizes (Fig. 46).

2. Lane's needle holder with very small needles (Fig. 47). This was originally devised for suture of the bile ducts.

3. One small, strong knife. A Jones' tenotome will serve admirably.

4. Fine, sharp-pointed scissors.

5. One strong hemostat with mouse teeth at the point.

6. Fine, strong silk.

7. A good mouse-tooth dissecting forceps suitable for catching the tissues or the end of a needle.

TYPE A.—The cleft in the hard palate is unilateral. The septum is continuous with the hard palate on one side. The alveolus and the soft palate are also cleft.

Step 1.—Formation of reflected flap. Make the incision 7, 5, 6, 8 through the muco-periosteum to the bone (Fig. 48). In order to obtain plenty of tissue that part of the incision represented by the line from 5 to 6 is made on the outer surface of the alveolus near the reflection of the mucosa from the alveolus to the cheek. Make the incision through the mucosa of the soft palate, but do *not* injure the musculature. Reflect flap 7, 5, 6, 8. The pedicle or hinge of the flap corresponds to the edge of the cleft in the palate.

In separating the muco-periosteum from the bone as the posterior palatine foramen is approached, an elevator pressed in between the flap and the bony palate causes the posterior palatine vessels and nerves to protrude for a considerable length in a tube of periosteum. This is readily grasped by an efficient hemostat, which is left in place until hemostasis is assured.

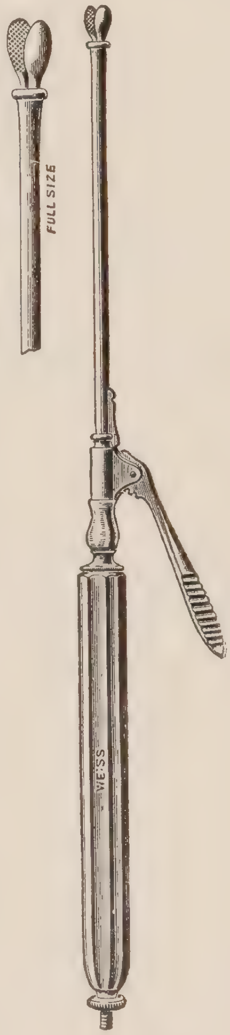


FIG. 47.—(*Lane*.)

That portion of the flap taken from the soft palate consists of mucosa and submucosa. It is important not to injure the muscles of the palate. The reflected flap is formed on the side of the cleft which is *not* attached to the septum.

Step 2.—On the side of the cleft attached to the septum proceed as follows: With forceps pull the uvula and soft palate forward so as to expose the nasal surface. Divide the mucosa along the posterior edge of the soft palate (4, 3, Fig. 48). Continue the incision across the nasal surface of the soft palate to the point where the soft and hard palates meet at the edge of the cleft (3, 2). Continue the incision forward along the edge of the hard palate (2, 1) and across the alveolus (1, 9). The part of the incision affecting the hard palate and the alveolus penetrates the

whole thickness of the muco-periosteum. The part of the incision affecting the soft palate penetrates only the mucosa and submucosa.

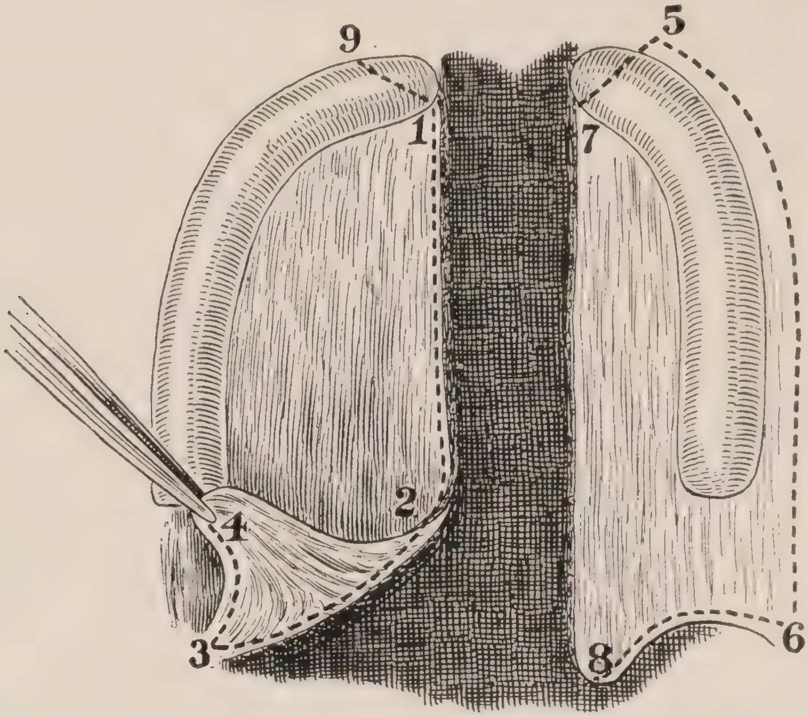


FIG. 48.—Lane's uranoplasty.

Reflect the mucous flap (2, 3, 4) outlined on the nasal surface of the soft palate. Introduce an elevator through the incision 9, 1, 2 and separate

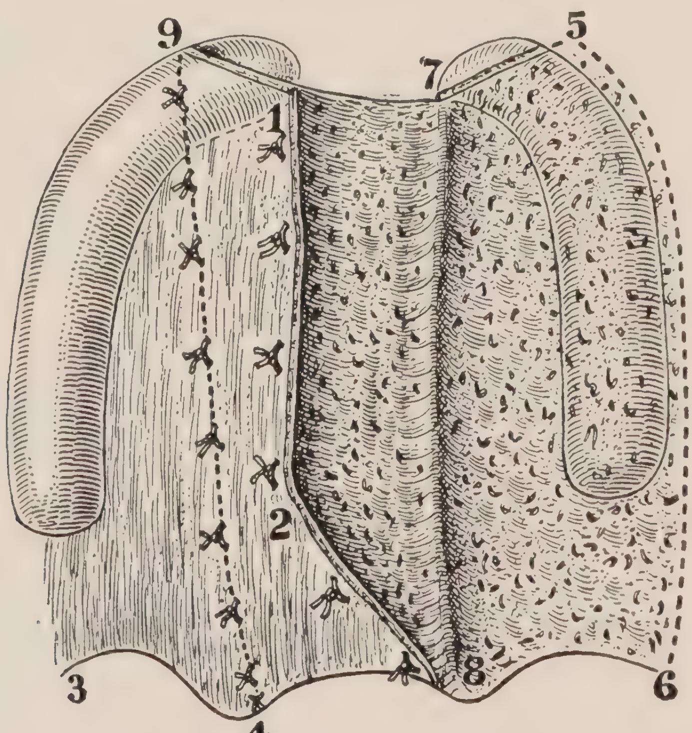


FIG. 49.—Lane's uranoplasty.

the muco-periosteum from the hard palate and to a slight extent from the alveolus near the point 9. Divide the attachments of the soft

palate to the hard palate along the posterior edge of the latter, leaving intact the mucosa on the oral side of the palate. During step 2 the posterior palatine artery remains uninjured.

Step 3.—Turn the flap 5, 7, 8, 6, so that its epithelial-covered surface is directed toward the nose and its raw surface toward the mouth.

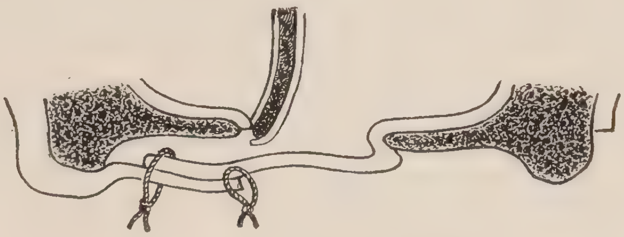


FIG. 50.—Lane's uranoplasty.

Tuck the edge of flap 5, 7, 8, 6 well under flap 9, 1, 2, 3, 4 and fix it in position by two rows of fine sutures (Figs. 49 and 50).

TYPE B.—The cleft is wide; the septum is not attached to the palate; the alveolus is not cleft.

Step 1.—Make the flap 1, 2, 3 (Fig. 51) as in type A.

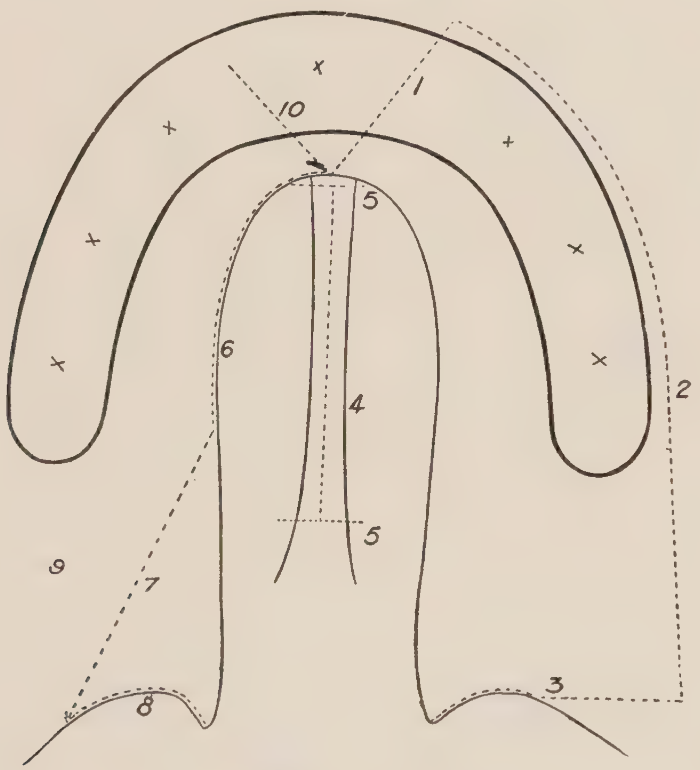


FIG. 51.—(*Lane.*)

Step 2.—On the opposite side make the incision 6 through the muco-periosteum along the edge of the cleft. Make the incision 7 and 8 on the nasal surface of the soft palate and reflect a flap of mucosa from the soft palate as in type A. Separate the muco-periosteum from the hard palate and divide the attachments of the soft to the hard palate along

the posterior edge of the latter, leaving intact the mucous membrane on the oral surface.

Step 3.—Turn flap 1, 2, 3 over, with its epithelial surface directed toward the nasal cavity, so as to cover the cleft.

Tuck the free edge of this flap well under the flap 10, 6, 7, 8. The triangular portion of this latter flap, which was obtained from the nasal surface of the soft palate, assists greatly in providing a thick new velum palati.

Step 4.—Suture the edge of flap 1, 2, 3 to the base of flap 10, 6, 7, 8 (Fig. 52). Suture the edge of flap 10, 6, 7, 8 to the raw surface of flap 1, 2, 3 (Fig. 52).

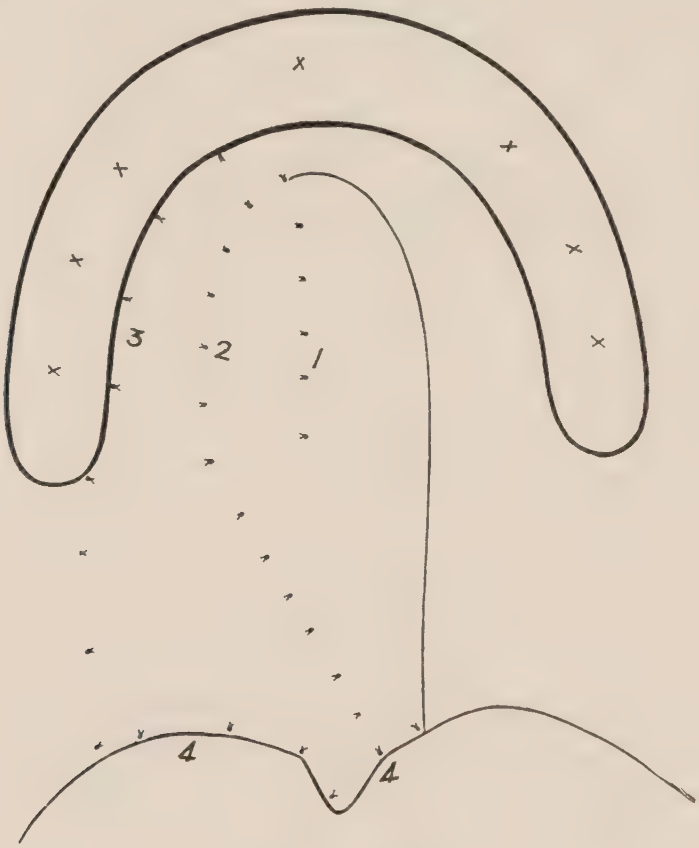


FIG. 52.—(*Lane.*)

After the milk teeth have erupted some modification of Lane's methods or the classical operation of Langenbeck may be selected.

Langenbeck's Operation.—Pass a thread through the tongue for purposes of traction. Introduce an efficient mouth gag (Whitehead's, Lane's, a wedge of wood).

1. Denudation.—Seize the end of the uvula on one side with a sharp hook or forceps (Fig. 53). With a sharp knife or tenotome remove a strip of mucous membrane from the whole edge of the cleft. In cutting, do so obliquely, removing rather more membrane from the oral than from the nasal side of the palate. This gives a more extensive

raw surface, which is a great advantage. When the soft palate is very thick, its edge may be split instead of pared.

2. With a suitable periosteotome or knife divide the muco-periosteum along the edge of the cleft in the hard palate. Separate all the muco-periosteum from the hard palate up to the alveolus (Fig. 54). For this procedure Brophy's periosteotomes are convenient, but a suitable instrument is easily extemporized from a dental spatula or even an aneurism needle.

3. The soft palate may be said to consist of three layers: (*a*) The nasal mucous membrane; (*b*) the tissues attached to the posterior

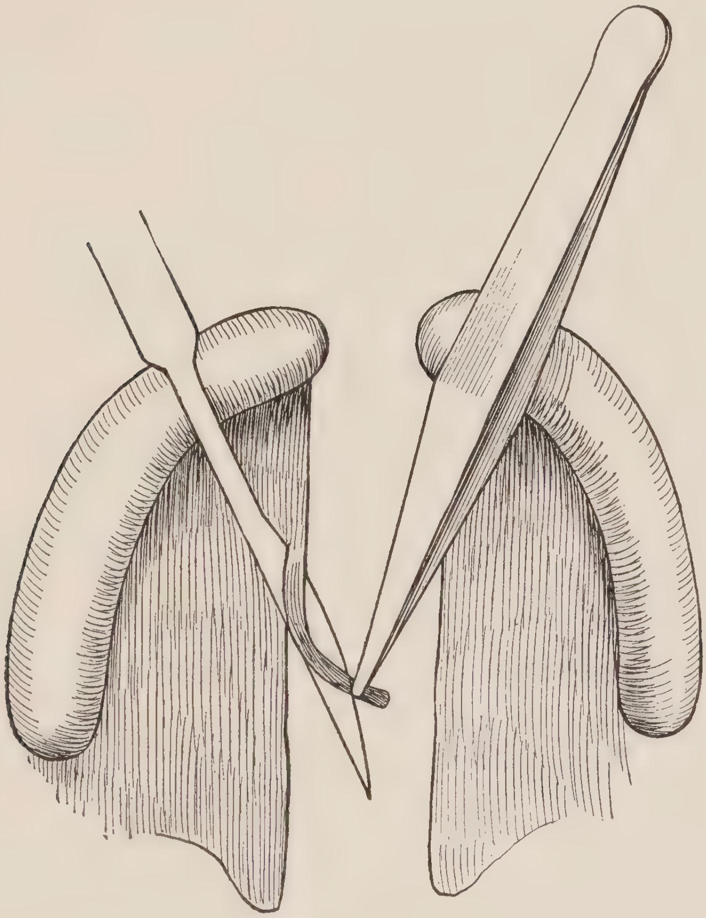


FIG. 53.

edge of the hard palate; (*c*) the oral mucous membrane. Leaving intact the oral mucous membrane, which is continuous from hard to soft palate, divide transversely with fine curved scissors both the nasal mucous membrane and the tissues attached to the posterior edge of the hard palate. This is one of the most important steps in the operation, allowing the muco-periosteal flap obtained from the hard palate to drop toward the mouth, and with it the soft palate (Fig. 55).

Repeat this procedure on the opposite side. Commonly the raw edges of the flaps thus obtained will come into apposition without

tension. If they do not, it is necessary to make a lateral incision through the muco-periosteum parallel and close to the alveolus on one or both sides of the mouth, and extending from the lateral incisor back to the posterior margin of the hard palate. If this is insufficient to relieve tension, Billroth's procedure may be adopted as follows: pass a fine chisel through the posterior angle of the lateral incision; direct it obliquely inward and upward against the hamular process, and with a light blow from the hand make it divide that bone. The dislocation of the hamular process, increased if necessary by the use of an elevator, gives perfect relaxation of the velum palati and does not injure its musculature. *Incisions through the soft palate dividing its muscles* were formerly considered necessary; *now they are never admissible.*

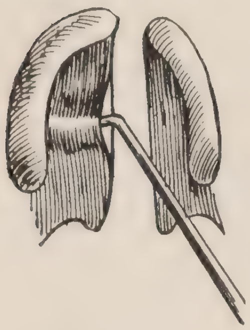


Fig. 54.

C. H. Mayo considers it important to make lateral incisions (Fig. 56) on both sides, not merely to relieve tension, but to permit the use of a

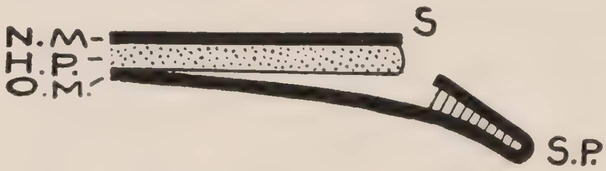


Fig. 55.

N. M. Nasal mucosa. H. P. Hard palate. O. M. Oral mucosa. S. P. Soft palate. S. Line of section

relaxation tape. Having prepared the parts for the insertion of sutures, and having made two lateral incisions close to the alveoli, he introduces a narrow tape which surrounds the right and left muco-periosteal flaps. Traction on the ends of the tape brings the flaps toward the operator,

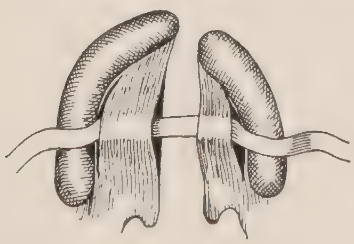


Fig. 56.

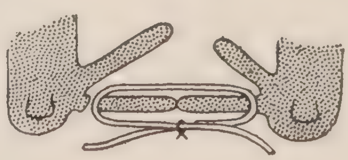


Fig. 57.

steadies them, and facilitates the introduction of the ordinary sutures. When the sutures are in place and tied, Mayo crosses the free ends of the tape and fixes them by tying a ligature around them at this point (Fig. 57), cuts off the superfluous portions of the tape, and lastly slides the whole tape until that part fastened by the ligature lies in the nasal instead of in the oral cavity. The tape fastened as above acts as an efficient relaxation suture or support; it also drains secretions from the

nasal cavity into the mouth. It is remarkable how this very simple contrivance facilitates the operation.

4. Sutures.—Many special needles have been devised to overcome the difficulties met with in closing palatal defects. Of these, Deschamp's (Fig. 58) is perhaps the best, although it is usually made too large. The writer finds that he can discard such special instruments by using very small, full-curved needles, grasped in a long-necked needleholder,

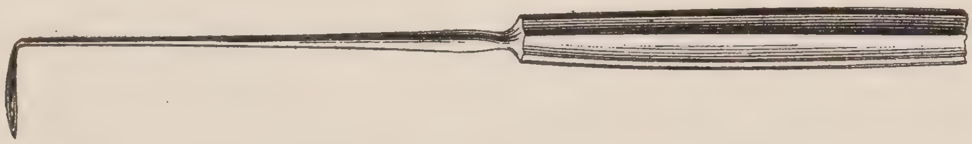


FIG. 58.

and passing each end of the thread, armed with a needle, from the nasal to the oral side of the palate, *i.e.*, from within outward. The usual method of suturing is to begin at the uvula and work forward, being careful to *evert* the edges of the wound when the flaps from the hard palate are being united. Silk or celluloid hemp are the materials used.

After-treatment.—Liquid or soft food is alone permissible. Antiseptic sprays may be used if not annoying to the patient. The patient should get out of bed and, in suitable weather, out of doors as soon as possible. The sutures must not be removed earlier than the seventh day after operation.

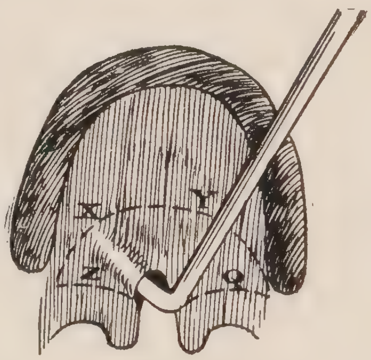


FIG. 59.
Z and Q. Line of separation of attachments of velam to hard palate. X, Y, Z, Q. Area in which muco-periosteum (continuous with the velum) is separated from the bone.

Partial Cleft Palate.—When there is a cleft of the soft palate alone and the edges can be brought together without tension, one is content to pare the edges and apply sutures. When the cleft in the soft palate reaches close to the hard or when the latter is partially cleft, it is absolutely necessary to relieve tension. This is done in the same fashion as in complete cleft palate, by dividing the attachments of the velum to the hard palate and by separating the muco-periosteum from the bone to as great an extent as may be necessary Fig. 59).

Lane's Operation.—TYPE C.—Wide cleft of soft palate.

Step 1.—Reflect the flap 1, 5, 6, 7, 8 (Fig. 60) with its base at the edge of the cleft.

This flap consists partly of muco-periosteum from the hard palate and alveolus and mostly of mucous membrane from the soft palate and cheek. The flap must be large enough to easily cover the defect. Do not injure the musculature of the soft palate.

Step 2.—From the *nasal* surface of the soft palate on the opposite side of the cleft reflect the flap 1, 2, 3, 4 with its base at the edge of the cleft.

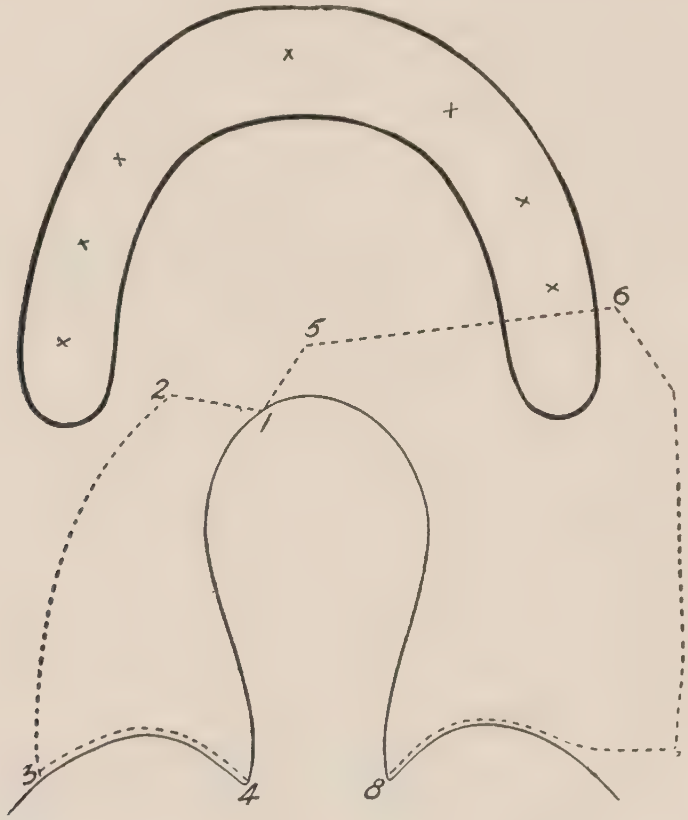


FIG. 60.—(*Lane.*)

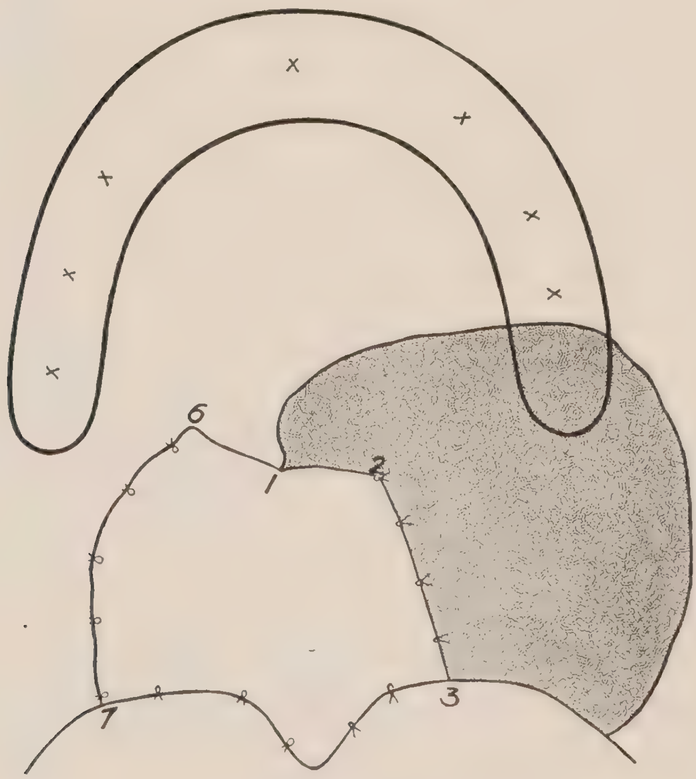


FIG. 61.—(*Lane.*)

Step 3.—Suture the two flaps together, one over the other in an overlapping fashion (Fig. 61).

SECTION VI

CONGENITAL DEFECTS

BY

JOHN FAIRBAIRN BINNIE, A. M., C. M., F. A. C. S.

Congenital Deformities of the Nose and Face Other than Hare-lip.—The lines of fusion shown diagrammatically in Fig. 25, page 81, give a hint as to the many deformities which may result from faulty coalescence.

1. The internal nasal processes may fail to perfectly fuse one with the other. The notch-like dimple seen at the point of many handsome

FIG. 62.—Median fissure of nose. (*Nasse. v Bergmann's Clinic.*)

noses is a mark of fusion which *almost* failed to be complete. Between mere dimpling and the extensive fissures shown in Figs. 62 and 63, all degrees of deformity may be found.

When the failure in fusion is confined to the lowest part of the internal nasal processes median hare-lip results (Fig. 64); or there may be a

cleft through the intermaxillary bone. Imperfect development of the internal nasal processes may result in absence of the intermaxillary bone.

FIG. 63.—Median fissure of face. (*Bougon and Derocque Rev. d'Orthop*, 1908.)

Instead of fissures and dimples incomplete fusion may give rise to sinuses opening on the skin and passing upward in the median line. These sinuses are lined with epithelium and from them hairs may protrude (Fig. 65). A sinus such as has been described may exist without any external opening and give rise to a dermoid cyst. Dermoids existing at the root of the nose have a different origin, being derived from the anterior end of the medullary groove of the embryo.

FIG. 64.—Median hare-lip. (*Ransohoff.*)

2. The external nasal process may fail to perfectly fuse with the internal process and so give rise to lateral clefts or fissures of the nose (Fig. 66).

3. The superior maxillary process may fail to perfectly fuse with the external nasal process. From this failure a cleft may extend from the outer canthus of the eye outward and upward, or a dermoid may form there. Clefts of the cheek usually involve the middle of the lower eyelid and the upper lip external to the outer edge of the lunula (Fig. 67). It is this course of clefts of the

cheek which presents the strongest evidence in favor of Albrecht's views on development (page 80). In this deformity the eye is often badly developed or even absent.

FIG. 65.—(*Bland Sutton.*)

FIG. 66.—Lateral cleft of nose. (*v. Bergmann.*)

FIG. 67.—(*From Choyce's System of Surgery, Vol. 2, Cassell & Co.*)

Imperfect closure of the nasomaxillary fissure may give rise to dermoid cysts or to fistulæ at any point on its course.

4. The superior maxillary processes may fail to unite with the rest of the first branchial arch (the mandible) or may unite with them too completely.

Bilateral failure of union may give rise to a symmetrical but inordinately large mouth. Unilateral failure produces a lateral cleft—macrostoma (Figs. 68 and 69). Fistulæ or dermoids may result from imperfect closure of the fissure. Frequently tags of skin grow as tumors

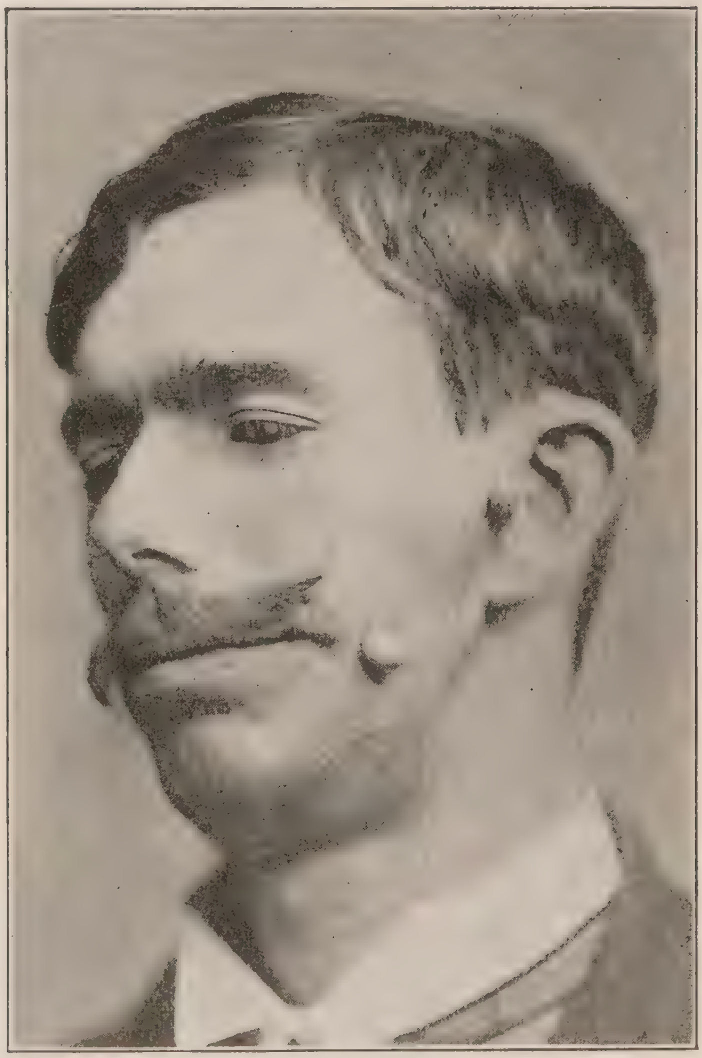


Fig. 68.—Macrostoma with accessory auricles.

along the line of the fissure and are known as mandibular tubercles. Accessory auricles not infrequently accompany macrostoma (Figs. 68 and 69). When fusion is too complete the mouth is too small—microstoma.

Treatment of Macrostoma and Microstoma.—The treatment of macrostoma is almost identical with that for hare-lip.

When microstoma is of such a degree as to be a deformity, a plastic operation along the following lines is advisable.

From the angle of the mouth make an incision outward through the

skin down to but not involving the mucosa. The length of the incision corresponds to the size of mouth desired. Divide the mucosa to a point about $3/4$ inch internal to the outer end of the skin incision; at this point bifurcate the mucosal incision so as to form a triangular flap (with its pedicle external) of mucosa; bring the flap forward and suture it to the skin so that it forms a mucosal covering to the angle of the new mouth. Suture the mucosa to the skin along the whole line of incision. Do the same on the opposite side of the mouth.

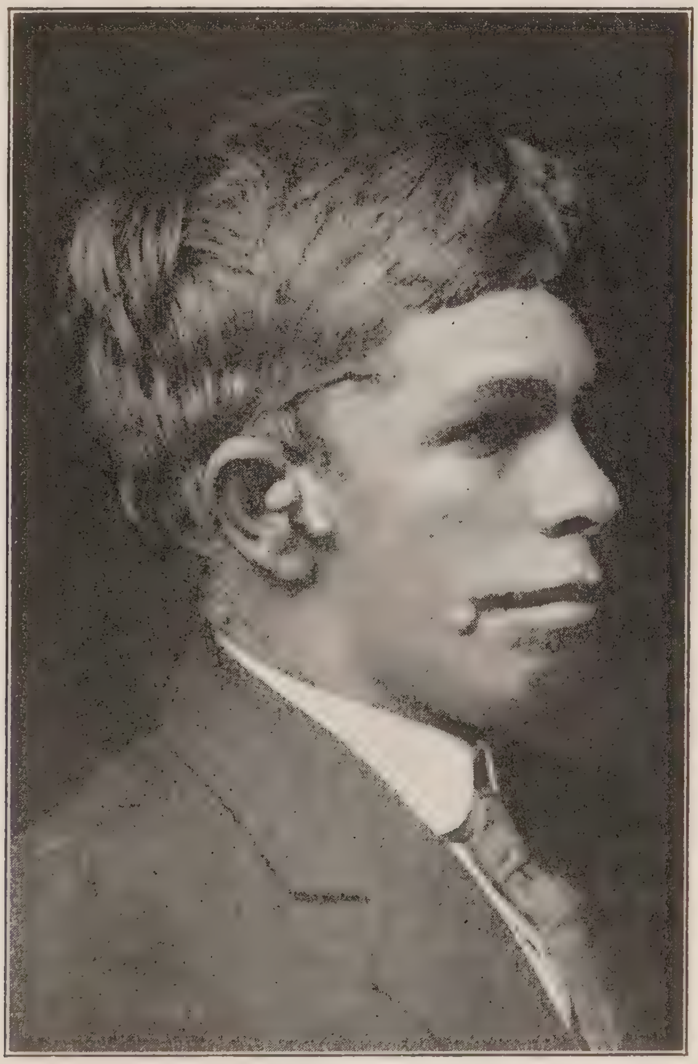


FIG. 69.—Macrostoma with accessory auricles.

5. The mandibular process (I Branchial Arch) may fail to unite completely with its fellow on the opposite side. The result of this might be a complete or an incomplete (Fig. 67) cleft, a fistula or a dermoid. The dimple so commonly seen on chins is a hint that its possessor might have been the subject of a serious deformity.[1]

[1] Stieda (Archiv für Klin. Chir., LXXIX, Hft. 4) states that the branchial arches are not *paired* structures, *e.g.*, the first arch is a complete hoop going from one side of the body to the other. If this view is correct, then median fissures and fistulæ of the lower lip and jaw must be due to a want of growth of the arch in the middle line. The various degrees of

"In children with double hare-lip two sinuses are sometimes seen in the mucous membrane of the lower lip. Their orifices are indicated by small but prominent papillæ. The sinuses are large enough to admit a probe, and they are in some instances 2 cm. deep. * * * * These sinuses are probably due to faulty coalescence of the intermandibular fissure" (Bland-Sutton).

Fissures of the lower lip and of the lower jaw are exceedingly rare.

Deformities of the External Ear.—In the chapter on embryology it was shown that the external meatus is a remnant of the first branchial cleft and that the pinna is formed by the fusion of various buds of tissue which Bland-Sutton compares to the opercula in sharks.

FIG. 70.—Rudimentary auricles.

Too complete fusion of the first branchial cleft may prevent the formation of the external auditory meatus and the tympanic cavity; incomplete fusion of the buds of tissue, which ought to form the pinna, may leave that organ represented merely by some tags of skin.

Figure 70 shows such a rudimentary ear, the external auditory meatus was absent and the man was entirely deaf. Slight errors in fusion of the rudiments of the ear give rise to fistulæ and to dermoids. Fig. 71 represents a boy with a fistula in each ear 1 cm. deep. Among five members of the patient's family, three had auricular fistulæ. In the photograph a salivary fistula, the result of phlegmon, is seen but has no connection with the fistula.

Maldevelopment of any of the buds going to form the ear may lead to much deformity.

Bland-Sutton's remarks on the presence of opercula on the branchial arches (p. 84) explains the occurrence of accessory auricles along the lines of the branchial clefts (Fig. 69). These auricles occasionally appear on the neck and consist of tags of skin often containing cartilage.

Branchial Cysts and Fistulæ.—It has been shown in the chapter on embryology that the third and fourth branchial arches become hidden

fissure and of fistula formation are explained by subsequent greater or less median fusion of the developed lateral parts of the arch.

in an irregular cavity, the precervical sinus, the anterior wall of which consists of the operculum. Normally the precervical sinus disappears and fusion between the branchial arches is complete.

Failure of complete obliteration of the precervical sinus and of the branchial clefts gives rise to *lateral cysts* and *fistulæ* of the neck.

There are four forms in which branchial clefts may persist·

1. Complete fistula, usually involving the second cleft.
2. The external or ectodermic portion of the cleft persists.
3. The internal or endodermic portion persists.

FIG. 71.—Fistula in external ear.

4. Both the internal and external orifices disappear but an intermediate portion persists. This last form may give rise to cysts or even provide the epithelial elements for a subsequent carcinoma.

When the fistula is of the second cleft its inner orifice is in the tonsillar recess. Some pharyngeal diverticulæ are very probably examples of blind internal fistulæ of the second branchial cleft. Fritz König (Archiv für Klin. Chir., LI, p. 594) reports a fistula of the second cleft; the upper opening was in the external ear between the tragus and antitragus, the lower a short distance below the angle of the jaw. Fistulæ

of clefts other than the second are very rare. The same surgeon saw one of the third cleft, the inner orifice being in the larynx.

The external openings of almost all congenital fistulæ of the neck are due to failure in obliteration of the precervical sinus and are thus situated internal to the anterior margin of the sterno-mastoid muscles. The external orifices may be at any level in the neck *below* the digastric muscles.

A branchial cyst may increase in size, become infected and discharge its contents internally or externally and so give rise to a blind internal or blind external fistula. In the same manner (theoretically at least) a blind internal fistula may open externally and become complete.

An internal fistula being of endodermic origin is lined by mucous membrane and in its walls lymphoid tissue is commonly present. An external fistula is of ectodermic origin and thus is lined by epidermis with its derivatives and so may contain hair, sebaceous material, etc.

A complete fistula is lined by epiderm externally and mucous membrane internally.

A branchial cyst may be epidermal or mucous according to whether it originates from the pharyngeal or from the external part of a cleft.

Branchial fistulæ are frequently bilateral and certain families seem to have a predisposition toward them.

The orifices of the fistulæ vary in size, being usually so small as to barely admit a bristle. The external orifice may be indicated by a tag of skin containing a piece of yellow elastic cartilage and forming a cervical auricle (Bland-Sutton). Cervical auricles may be present in the neck without any other deformity, just as similar accessory auricles may be found on the cheek with or without macrostoma.

Treatment of Branchial Cysts and Fistulæ.—The only true treatment of branchial cysts and fistulæ is by excision. Many fistulæ give little or no annoyance and require no treatment; others are deforming or give vent to an annoying discharge. Often fistulæ become inflamed, causing pain and much trouble which cannot be cured without removal of the whole tract.

Partial excision of a fistula is usually followed by recurrence. For the excision of a complete fistula the skin incision must be large and the whole fistula must be dissected free from its surroundings until it hangs like an appendix from its pharyngeal connections. The most difficult part of the operation is the dissection near the pharynx and the closure of the pharyngeal wound. Fritz König has avoided some of these

difficulties as follows: After mobilizing the fistula to a point near the pharynx (behind the tonsil), open the mouth with a suitable gag; pass an eyed probe from the wound into the mouth through a small incision anterior to the tonsil and by its means pull a thread into the mouth. Tie the end of the thread to the mobilized fistula and pull the latter through the wound into the mouth; cut away the excess of the fistula and suture its stump to the oral mucosa. Close the external wound. Instead of a long fistula leading from the pharynx to the neck there is left a short harmless passage leading from the back to the front of the tonsil.

Median Cysts and Fistulæ of the Neck.—It was shown in the chapter on embryology that the tongue is developed from three buds and that an endoderm-lined canal (the thyreo-glossal duct) exists at the point where these three buds come together; the lower part of this canal forms the median part of the thyroid. The body of the hyoid bone (part of the 3rd branchial arch) is naturally closely connected with the thyreo-glossal duct; in fact the bone may be perforated by the duct. Normally the thyreo-glossal duct disappears, but it may either remain more or less patent or its epithelial elements may proliferate. The epithelium being of the same origin as the thyroid, it follows that when it has proliferated the resulting mass is often of the same structure as the thyroid and may be considered an accessory thyroid. Accessory thyroids may form at any part of the thyreo-glossal duct; when they are present in the tongue they are sometimes known as *lingual thyroids*.

The duct may remain open throughout its whole extent as a passage lined by ciliated epithelium. The lower portions may be provided with diverticula. In other instances the duct becomes converted into a fibrous cord. Partial obliteration of the duct often gives rise to retention cysts which, according to their sites, may cause a tumor in the floor of the mouth (some forms of ranula), in the tongue, or in the median line of the neck. Such cysts contain mucoid material and may vary in size from that of a small nut to a small orange.

Fistulæ arising from the thyreo-glossal duct never possess an aperture through the skin unless they have perforated the skin secondarily through their growth or because of inflammatory changes. Once an external fistula forms it never heals unless all the patent canal with which it communicates is excised. Sometimes (Fig. 72) a fibrous cord and fistula lead from a median cyst to the skin lower down in the neck.

Dermoid cysts and fistulæ of the middle line of the neck and of the tongue are commoner than the mucous variety but have an entirely

different origin, being due to imperfections in the fusion of the branchial arches of one side with those of the opposite side. Such cysts and fistulæ are practically identical, except in situation, with the lateral branchial lesions.

Treatment.—The only treatment for median cysts and fistulæ of the neck, floor of the mouth or tongue, of whatever origin, is complete exci-

Fig. 72.—Median cyst and fistula of neck.

sion. Butlin (Burghard, Op. Surg., II, 213) has seen hypothyroidism result from the removal of a solid thyreo-glossal duct tumor from the tongue. It must be remembered that an apparently accessory thyroid may be the real functioning gland.

SECTION VII

INJURIES AND DISEASES OF THE FACE AND JAW (NOT INCLUDING CONGENITAL DEFECTS)

BY

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Fractures of the Lower Jaw.—Fractures of the lower jaw are of more frequent occurrence than of the other bones of the face, on account of its position, its shape and its size. The motility of the head and the natural impulse of the individual to protect the face from anticipated blows and falls, however, prevent many fractures. Fractures are more common

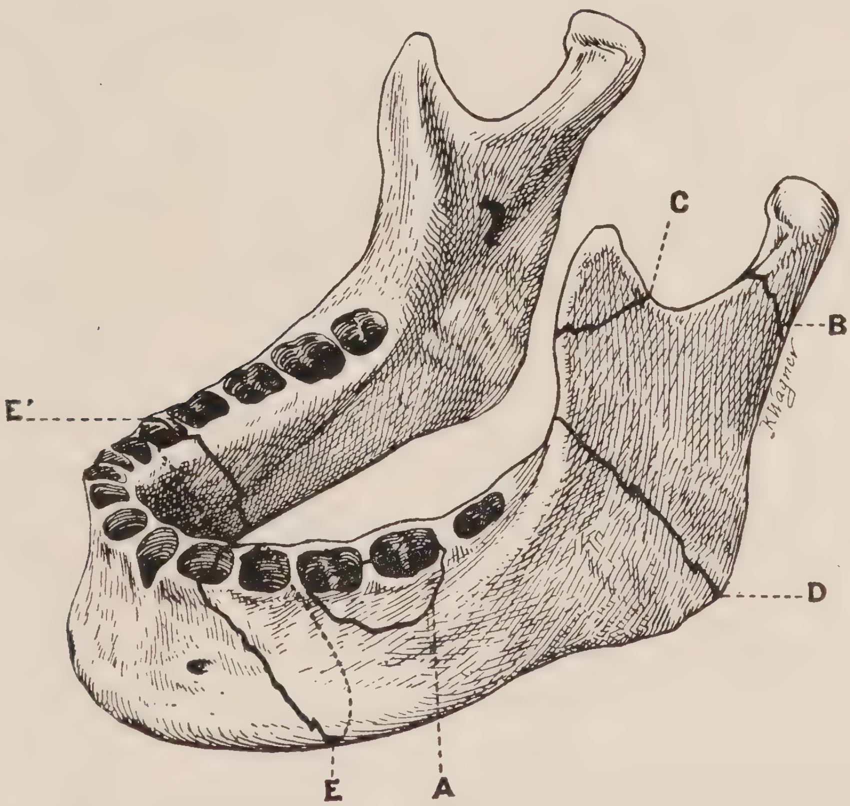

FIG. 73.—Fractures of the lower jaw. *A*, Fracture of the alveolar border; *B*, fracture of the condyle; *C*, fracture of the coronoid process; *D*, fracture of the ramus; *E*, unilateral fracture; *EE'*, double fracture. The median fracture is not shown. (*Le Dentu et Delbet.*)

among men than women because of greater exposure in their daily occupations (Fig. 73). A sudden blow, kick, fall, automobile or run-over accident, may break the lower jaw, and it depends on the location and direction of the striking force as to what part, or parts, of the bone may be broken; an indirect force, *e.g.*, a blow on the top of the head when the chin is resting on a hard surface, may fracture

the jaw. Fractures of the alveolar border are very common, often being caused by dentists in extracting teeth. The most frequent fractures occur through the body of the jaw (40 out of 43 cases, Hamilton); usually the maxilla is fractured toward its anterior extremity where the bone is weakened by the extreme depth of the alveolus of the canine tooth. The line of fracture usually passes obliquely downward and outward. Displacement of the fragments (Fig. 74), depends upon two factors, the direction and amount of the contusing force, and the traction of the muscles attached to the different fragments. When only one side is fractured the rear portion is drawn upward, outward, and forward by the masseter and temporal muscles, while the anterior fragment is drawn in the opposite direction by the hyoid muscles; the smaller fragment then overlaps the larger. Frac-

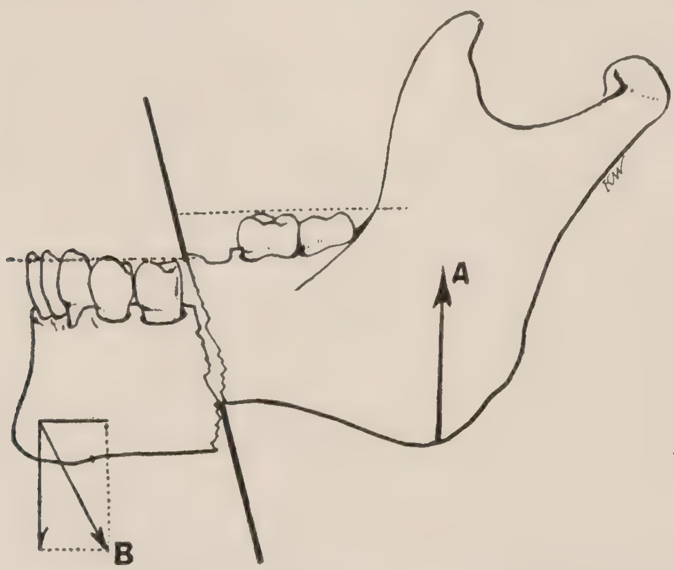

FIG. 74.—Lateral fracture of the body of the lower jaw. *A*, Traction due to the masseter, the internal pterygoid and the temporal muscles; *B*, traction due to the genio-hyoid muscles. (*Le Dentu et Delbet.*)

tures of the median portion of the jaw are rare, but when they *do* occur the line of fracture is in general vertical, and there is very slight displacement. Multiple and comminuted fractures are common, and usually the fracture is compound because of the tearing of the mucous membrane of the mouth, or because of an external wound of the soft parts covering the jaw. If both sides are broken the line of fracture is most often at the canine alveolus on one side and just anterior to the insertion of the masseter muscle on the other side; the diplacement is the same as in unilateral fracture, except that it is more marked. Crepitation is very noticeable, and this in itself is enough to show positively the existence of a fracture. The patient cannot talk; it is impossible for him to chew, and deglutition is very painful.

The coronoid process is very rarely fractured, and then only when associated with other fractures. If the ascending ramus is fractured the masseter and internal pterygoid muscles prevent displacement of the fragments. A fall on the chin, or a blow on the side of the jaw, may fracture the condyle; when the fracture is unilateral the condyle is displaced forward by the external pterygoid, and the chin is deviated toward the affected side. If both condyles are broken, the lower jaw is displaced backward and the teeth lose their natural relations. All fractures of the lower jaw, behind the anterior insertion of the masseter muscle, are most accurately diagnosed by the X-ray.

Treatment.—As most fractures are compound they have every opportunity to become infected because of the many different kinds of bacteria always present in the mouth; the infection is seldom of a severe type. Treatment consists, as in other fractures, first, in reducing the fracture, and second, in the fixing of the bone so that the fragments will unite in such a way that there shall be proper alignment of the teeth. In fractures of the body, if there is not much displacement, the surgeon moulds the parts into proper shape, sees that there is a proper alignment of the teeth, closes the mouth and holds the lower jaw firmly against the upper jaw. If there is much displacement more manipulation is required in the reduction: the ends have to be drawn in opposite directions to overcome the overlapping; the disturbed teeth should be replaced in proper alignment. If a tooth is found free in the mouth, or between fragments, an attempt should be made to save it by replacing it in its socket, binding it if necessary to its neighbors by a silver wire. A careful examination for the presence of a tooth between the fragments should never be neglected. The writer has seen one case where such a complication prevented union for three months before discovery and removal of the tooth resulted in prompt repair. Reduction having been affected, it is maintained in the majority of cases by the use of a four-tailed jaw bandage, or the Barton bandage, applied directly over a mould made of pasteboard, felt, or leather, the vertical arms of which should pass well up upon the side of the jaw. The bandage binds the lower jaw firmly against the upper jaw.

Repair.—These fractures usually unite in four or five weeks without deformity sufficient to cause functional impediment. Non-union seldom or never occurs. If all the teeth are present there may not be sufficient space between the upper and lower teeth for the administration of liquid nourishment and the proper cleansing of the mouth, without loosening the bandage for the introduction of food; this, in a degree,

disturbs the fragments, causes pain and delays union. Pieces of non-vulcanized gutta percha (base-plate gutta percha which is insoluble, softens at 200°F., dry heat, hardens at 90°F., and is quite rigid, is the best material, and does not require vulcanization), may be softened in hot water, formed into wedges, and placed on either side over the crowns of the teeth, the one on the fractured side covering as nearly as possible, near its middle, the line of fracture. The jaw is closed and pressed firmly against the upper jaw until the teeth on each side of the fracture are in perfect alignment. When the gutta percha has hardened it is removed and trimmed so as not to irritate the sides of the cheek or the tongue. Then a sufficient number of the opposite teeth of the two jaws may be wired, one to another, to hold the interdental splint firmly in position, or reliance for this purpose may be placed upon the application of a four-tailed bandage. Even when the wiring is resorted to, a four-tailed bandage should be employed to give further support. This interdental splint allows a sufficient space between the teeth to admit of the giving of a bounteous quantity of soft food, and the frequent irrigation of the mouth which is most essential to the comfort of the patient and for the removal of the causes of bad breath due to putrefaction within the mouth. The method of introducing food through a tube passed through the nose, or behind the last molar tooth, is exceedingly disagreeable and painful to the patient and should not be practised. These methods, however, and the administration of food by the rectum, may be used as temporizing measures when the injury is complicated by serious shock due to more extensive injuries than the fracture of the lower jaw alone. Many forms of ingenious interdental splints have been introduced by dentists, and in important cases it may be wise to seek a dentist's aid. A number of intrabuccal forms of apparatus have been introduced, but all have the practical defect that they necessitate the taking of an impression of the fractured dental arch, which is a difficult and painful manœuver besides requiring the material and skill of a specialist in dental surgery. The Kingsley apparatus is probably the most useful of this kind. It is indicated particularly in bilateral fracture of the mandible or in any case where there are two or more fractures of the mandible. It is contraindicated where there is much œdema and infection resulting in external suppuration. Great care should be exercised in placing the bandages under the chin as too much pressure is apt to result in pressure necrosis. The Kingsley splint (Figs. 75 and 76) is contraindicated in any single fracture; other methods may be better applied. A ready-made form of apparatus is that of

Matas, which consists of three different-sized soft block tin moulds, shaped to conform to the usual line of the teeth in different aged and developed individuals; the moulds are attached to aluminum chin plates. The downward pressure of the block tin moulds, and the counter-pressure of the aluminum cup-shaped chin plate (Fig. 77), is made by a thumb screw. In use the apparatus is reinforced by a

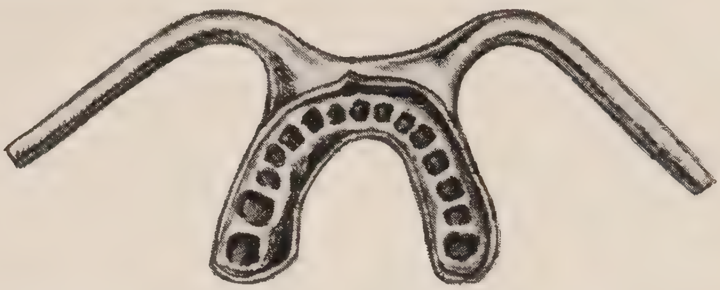

FIG. 75.—Kingsley splint, showing under surface with indentations. (*Le Dentu et Delbet.*)

four-tailed bandage. Some surgeons resort to a direct suture of the bone with heavy wire; this seems unnecessary unless there may be unusual complications, with more or less contusion and division of the soft parts; the wire suture is passed through drill-holes made in the bone below the level of the roots of the teeth. It can usually be removed in three weeks. When the alveolar border is fractured it should be carefully reduced, broken or detached teeth should be placed in their natural positions, resorting to the use of silver wire to secure them if necessary, and the parts immobilized as in other fractures of the body of the jaw. No fragments of bone should be removed, as all fragments quickly unite because of the vascularity of the parts. In fractures of the neck of the condyle the displacement of the condyle by the external pterygoid may be difficult to overcome. It should be reduced as far as possible, and the jaw immobilized. If there is marked deviation of the chin toward the fractured side, Sebilean overcomes this by fastening a metallic ring or wire around the superior canine tooth, another on the inferior large molars, and uniting these together by a heavy rubber band. This produces continued extension on the line of fracture. Fountain obtains the same results by wiring the teeth together after the jaw has been brought well forward. Landry recommends, and has employed at the suggestion of Matas, an Esmarch elastic

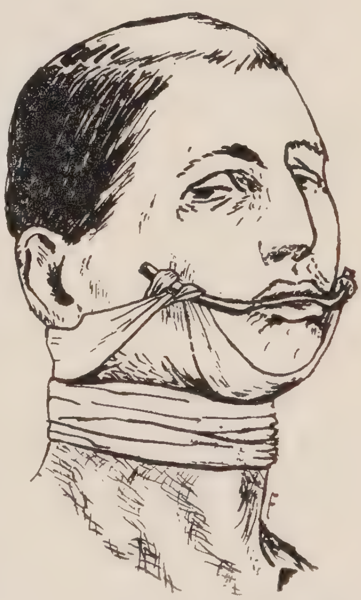

FIG. 76.—Kingsley splint applied.

bandage; this is used in multiple fractures of the jaw, or marked compound cases with separation of the alveolar process, or cases with great swelling and hemorrhage forbidding an intrabuccal appliance owing to pain and inability to keep the mouth clean. It is applied over sufficiently copious aseptic dressings, taking five or six turns around the head and chin, bringing the crowns of the teeth of the lower jaw into contact with those of the upper, and at the same time favoring and promoting the reduction and absorption of subcutaneous hemorrhage and œdema. It is recommended particularly in young children, as the milk teeth are not strong enough to support any sort of prosthesis.

FIG. 77.—Matas splint. (*Matas.*)

Fractures of the Nose.—As the result of direct violence one or both nasal bones may be broken and the cartilages may be dislocated. Usually a tear of the mucous membrane renders the fracture compound, but anything further than a mild sepsis seldom follows. Either the nose is displaced to one side or the nasal bones are crushed in, forming a flattening of the bridge, the so-called "saddle nose." In the lateral displacement the cartilage of the septum may be carried to the same side, and when the bridge is crushed in, the cartilaginous septum bends upon itself or tears at its junction with the ethmoid or vomer. The perpendicular plate of the ethmoid may likewise fracture, and the injury may even carry a fissure upward through the bone to the base of the brain. The nasal ducts are sometimes injured in such a manner as to obstruct the downward flow of tears; possibly a lachrymal abscess

may form; there is always more or less bleeding from the nose, but it is seldom sufficiently alarming to cause apprehension and require plugging of the cavity.

Treatment.—In lateral displacements the sides of the nose may be moulded into shape by the fingers, aided or not by a suitable blunt instrument passed into the nose. In crushed-in or "saddle nose" the same procedure may be followed; in some cases, however, it is necessary to grasp the septum between the blades of a strong forceps and, with a slight rocking motion, elevate the bones, while with the thumb and fingers of the other hand, the nose is moulded into shape. While a general anæsthesia is desirable, in the less severe injuries a local anæsthetic will suffice. Blowing of the nose after these injuries may cause emphysema of the face, the air entering through the torn mucous membrane; it should not cause serious apprehension. To retain the reduced fracture in position, often all that is necessary is to put a small gauze pad on one or each side, resting partly upon the superior maxilla and partly upon the nasal bones, and fasten these pads in position by a strip of adhesive plaster crossing both cheeks. In the crushed-in cases, it may be necessary to gain support from within, using iodoform gauze packing, so as to push the septum into position and support the nasal bones. A long, straight needle may be passed from side to side through the base of the nose, to assist in the prevention of the caving-in of the replaced "saddle nose"; the ends of the needle should be protected with cork. There is always an inflammatory swelling which interferes with breathing through the nose, but this subsides in a few days as repair progresses. Union is fairly firm in 10 or 15 days. Suppuration and necrosis occasionally follow, delaying repair, particularly if there has been much comminution of the fragments. Because of the early swelling it is not always easy to make perfect reduction of the displaced nose, and quite commonly evidence of the injury may be seen in after years; particularly is this so after crushed-in injuries.

Fractures of the Upper Jaw.—Fractures of the upper jaw are produced under two different conditions: first and most commonly, by a direct shock, as a blow in the face or a gun-shot wound; second, and of less clinical interest, by a force striking some other point than that where the line of fracture starts causing *indirect* or *radiated* fractures. The upper jaw is most likely to be fractured along any one of several different lines (Fig. 78): first, the alveolar border, rarely its entire length; second, a line of fracture may pass horizontally around the jaw just at the nasal

orifice. A third line may start near the middle of the nasal bones, run backward through the orbit, strike the pterygoid apophysis and break the zygomatic apophysis. Another (fourth) line of fracture is a branch of the last line separating from it in the orbit, and extending downward through the suborbital opening, then backward and upward again, to the main line. As in the lower jaw, small portions of the alveolus may be broken in the extraction of teeth. Most of the fractures of the superior maxillæ are benign, even though, through the tearing of the mucous membrane, they may open into the mouth—an extremely septic place.

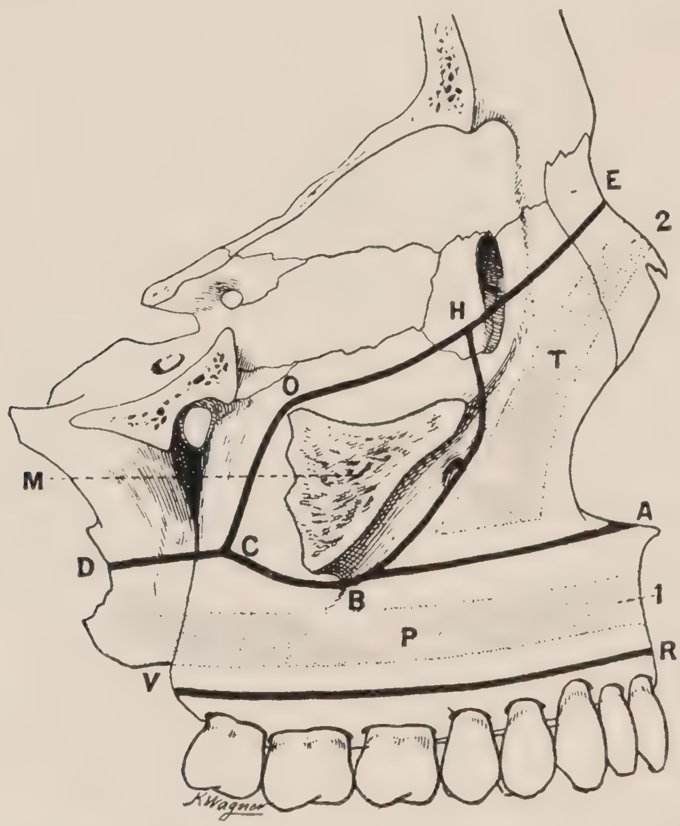

Fig. 78.—Lines of weakness in the bones of the upper jaw; *RV*, First line—alveolar border; *ABCD*, second line; *EHOCD*, third line; and *EHBCD*, fourth line. (*Le Dentu et Delbet.*)

Treatment.—Any fracture should be reduced as soon as possible, and kept in an aseptic condition. Fractures of the alveolar border, after being reduced, may be held in position by means of a gutta-percha mould such as is used in fractures of the lower jaw; the upper and lower jaws should be pressed firmly together and held in this position, thus preserving the proper alignment of the teeth. The four-tailed bandage may also be used—applied as in fractures of the lower jaw.

The zygomatic process of the malar bone is sometimes broken, allowing the malar bone to rock forward and break into the antrum; this fracture is readily recognized by the flattening of the side of the face; the fracture may be reduced by manipulation, or the bone may be

elevated into position by inserting a suitable instrument through an opening made in the mucous membrane in front of the anterior border of the masseter muscle. The zygomatic arch may be crushed in by a blow in such a way as to interfere with the function of the lower jaw. The fragments should be elevated by manipulation, or after incision.

The Temporo-maxillary Joint.—The intra-articular cartilage may become loose, and interfere with the function of the jaw, when there is quite constantly to be heard a crackling sound upon movement of the jaw, and if these movements are exaggerated a temporary locking may occur. The condition is seldom more than an annoyance but should the interference of function justify, it may be relieved by removing the cartilage or the cartilage may be sutured into position (Annandale).

Arthritis of the Temporo-maxillary Joint.—Arthritis may be either acute or chronic. The acute form is sometimes due to traumatism but more commonly occurs as a sequel or complication of constitutional infections, particularly the exanthemata. It is, therefore, more common in children than in adults. The symptoms are pain, tenderness, redness and swelling. Movements increase the pain. Should suppuration be added, constitutional symptoms may be marked. The abscess may point toward the surface over the joint, or, as in a recent case of the writer's, it may pass through the tympanic plate and appear as an otorrhea. The suppurative form may have its origin in middle-ear disease, osteomyelitis of the lower jaw, or parotitis, the infection spreading by direct contiguity. If the arthritis does not become suppurative the inflammatory products are absorbed, restoration of function takes place or fibrous ankylosis ensues. Following suppuration there may be complete disorganization of the joint, resulting in bony ankylosis.

Treatment.—The indications for treatment of the non-suppurative inflammations are the application of an ice-bag over the joint; talking should be interdicted and the jaw should be supported by a suitable bandage passed under the chin and around the head. Early evacuation and drainage of the pus is indicated in suppurative arthritis; in order to obtain proper drainage it may be necessary to resect the joint. An extraarticular origin of the infection must receive appropriate treatment. Rationally selected mixed stock vaccines may be useful.

Fixation of the Jaw.—Spasmodic or temporary closure of the jaw is due to a contraction of the muscles of mastication. When due to an irritation of the mandibular division of the fifth cranial nerve it is called trismus, and this may be caused by an impaction of a third molar

tooth. An X-ray examination will disclose this condition and the removal of the tooth will immediately relieve the symptoms (Fig. 79). Inflammations of the parotid gland and of the tonsil, carious teeth and local osteomyelitis of the jaw may cause temporary trismus, which disappears with the removal of the irritation. Trismus is occasionally simulated by hysterical subjects and is then best overcome by suggestion.

Organic Fixation of the Jaw.—Murphy divides these fixations into four classes: 1. Intra-articular conditions; this may be a fibrous ankylosis. 2. Bony ankylosis. 3. Peri-articular conditions. 4. Extra-articular muscular or cicatricial fixation on the side of the face or cheek, or a binding together of the alveolar processes from cicatrization following sloughing within the mouth.

FIG. 79.—Impacted third molar tooth.

The *diagnosis* as to the variety of fixation will depend upon the history of the case and the local examination. The recognition of which side is ankylosed is sometimes a delicate decision and mistakes have been made by experienced surgeons. The asymmetry of the face is not a constant sign of unilateral ankylosis, but usually the face is flattened on the side ankylosed. Under anæsthesia, however, it is always possible to obtain a slight opening of the jaw for from 5 to 10 mm. on the healthy side.

Treatment of Organic Fixation (*Ankylosis*).—All forms of organic fixation of the jaw are subject to a common danger during general anæsthesia, and this danger is asphyxia. It may arise from one of two causes: first, the entrance of vomited matter into the air passages, second, the falling back of the tongue into the pharynx, the so-called "swallowing of the tongue"; this must not be forgotten. It has been proposed by some to resort to a preliminary preventive tracheotomy, and the surgeon must, at least, always be ready to do a tracheotomy should the occasion demand.

If the fixation is fibrous, it is possible that it may be overcome by progressive dilatation of the mouth by different varieties of dilators. This can only be hoped for if treatment is instituted at a reasonably early period after the development of the fixation and there is still some motility. Forced dilatation under general anæsthesia has proven

a failure as experience has shown that any improvement is soon lost. Fibrous ankylosis which cannot be overcome by gradual dilatation, or bony ankylosis, are best remedied by resection of the temporo-maxillary joint, or by division of the neck of the condyle. There are two drawbacks to this procedure: one, the danger of injuring the facial nerve, and the other, the tendency to recurrence of the ankylosis. Injury to the facial nerve can be avoided by a proper incision both as to position and direction, and recurrence of the ankylosis prevented by inserting and fixing in the glenoid fossa, a flap of fat and fascia from the temporal muscle, between the two bones from which the temporal maxillary joint was formed (Nicoladini). The incision generally employed is a slightly curved one 2 inches in length, commencing on the zygoma about ½ inch in front of, and on a level with the auditory canal. The incision is carried upward over the zygoma into the hair, dividing the skin and superficial fascia. The superficial temporal artery and veins usually lie behind this incision but if encountered and in the way, they should be ligatured. The wound is retracted as the fascia is elevated from the zygoma with a periostotome. This manœuver separates the capsule from the condyle below, and exposes the joint. It must be borne in mind that the auriculo-temporal nerve runs up *behind* the condyle, while the internal maxillary artery crosses *below*. The condyle is elevated into the incision and divided with bone forceps. If the meniscus is diseased, it is excised. In some instances it may be advisable to divide the neck of the condyle for the interposition of the fascial flap, since rough elevating or gouging of the ankylosed head might result in injury to the base of the brain, as the roof of the glenoid fossa is very thin. If more room is required, the zygoma should be resected. In order to prevent recurrence of the ankylosis, Helferich, in 1893, practised the first resection with the interposition of a muscular flap. He turned down into the glenoid fossa a flap from the posterior border of the temporal muscle, having made a preliminary resection of the zygomatic arch, and sutured its free extremity to the aponeurosis of the parotid gland (Fig. 80). Huguier accomplished the same object by interposing a flap of muscle taken from the posterior part of the masseter muscle, the base of the flap being upward. The extremity was sutured as in Helferich's operation. The zygoma, of course, was not resected. These were successful methods, but to-day surgeons of most experience in this operation prefer to interpose in the joint a flap of the temporal fascia. Difficulty in opening the jaw, when due, not to intra-articular disease

but to shortening and adhesion of the soft structures, can be treated in two ways: first, the shortened masseter and internal pterygoid muscles can be loosened from their attachment to the inferior maxilla. To do this an incision is made under the jaw and toward its buccal border, to avoid a scar. With an elevator the masseter and the lower part of the internal pterygoid are freely loosened, care being taken not to extend the loosening of the latter so high as to injure the inferior maxillary nerve and vessels. Second, the difficulty can be treated by making a false joint in front of the adhesions and resecting the jaw.

Fig. 80.—Resection of the maxillary condyle; interposition of a muscular flap from the temporal muscle. *T*, Temporal muscle; *M*, masseter muscle. (*Le Dentu et Delbet.*)

The location of the resection must be varied to suit different cases. The piece of bone resected should be wedge-shaped with its apex at the alveolar border, and should be made in such a part of the jaw as to re-establish the center of motion as nearly comparable as possible with that which is normal. The masseter and internal pterygoid muscles can be used in interposition between the ends of the divided bone. The operation of Rizzoli-Esmarch, *i.e.*, the making of a false joint in front of the adhesions, and resecting the jaw, is not particularly to be commended, as many failures follow. It is better in the majority

of cases, to make a total extirpation of all cicatricial tissue and to fill in the defect by an immediate autoplastic operation. These autoplasties may be carried out by mobilizing flaps taken from the nighboring regions, from the arm directly, or "jump-flaps" may be taken from the abdomen to the arm, and from the arm to the defect.

Dislocation of the Jaw.—Dislocation of the jaw may be unilateral but it is more commonly bilateral; the displacement is forward. The accident seldom occurs among children or the aged and is most common among females. When the mouth is unduly opened in yawning, laughing, attempting to take too large bites, the condyle slips forward on top of the articular eminence and should the external pterygoid muscle contract sufficiently the condyle, with its meniscus, is drawn over the eminence into the hollow under the zygoma, and is held in this position by the contraction of the temporal and masseter muscles. Downward blows upon the chin or body of the jaw, and unskilled use of the mouth gag, have frequently caused the displacement. In some individuals a tendency to this accident is explained by relaxation of the capsule, as in habitual dislocation of the shoulder joint.

Symptoms.—The jaw is rigid, the chin is projected forward so that the lower teeth project beyond those of the upper jaw, and the condyle can be felt in its abnormal position; the coronoid process may be felt below the malar bone. The temporal muscle is tense. In unilateral dislocation the chin is directed toward the uninjured side. The mouth cannot be closed, saliva dribbles, and speech is guttural and indistinct.

Treatment.—Reduction is usually easily effected. The patient is placed upon a low stool or chair with an assistant standing behind and firmly supporting the head. The operator stands in front of the patient and, having protected his thumbs with a number of thicknesses of gauze, places them as far back as possible upon the molar teeth, while with his fingers he grasps the body of the jaw. With a downward and backward pressure, to overcome the contraction of the temporal and masseter muscles, and a slightly rotary motion, the condyles are lowered out of their false position into the glenoid fossa. In order to carry out this manœuver, the chin must be lifted upward, the reduction being the reverse of the mechanism of the dislocation. In difficult cases a cork or piece of soft wood may be placed between the molars on each side, to act as a fulcrum, and the jaw levered into place. The after-treatment consists in limiting the motion of the jaw for a few days by means of a four-tailed bandage, and the patient should be warned against opening widely the mouth.

In old cases, when manipulative measures of reduction fail, if interference with eating, the dribbling of saliva, and general discomfort of the deformity justifies, operative measures are indicated. The contracted masseter and internal pterygoid muscles may be loosened from their attachments to the inferior maxilla through an incision under the jaw, and then by manipulation reduction may be possible. Failing in this the condyles should be resected.

Incised and Contused Wounds of the Face.—Incised wounds are usually caused by sharp cutting instruments, but at certain locations

FIG. 81.—Incised wounds of the face, gaping widely because of the muscle traction (*Morestin.*)

an ordinary blow from any cause, particularly a hard, round instrument like a policeman's club, may produce a wound similar to an incised wound, except that its edges are apt to be irregular and somewhat contused: the tissues of the soft parts, catching between the striking instrument and the bone beneath, are split. This is likely to occur on the forehead, the cheek, and the chin; the lips are often badly wounded by being caught between or driven against the teeth. All incised wounds of the face bleed freely, and in the cheek especially

they gape widely because of the insertion of the muscles into the skin (Fig. 81).

Contused wounds are by far the more common; they are brought about by blows, falls, run-over or automobile accidents, explosions, and injuries from fire-arms, or entanglement in machinery. Very often such an extent of laceration accompanies these wounds as to cause serious shock.

Punctured wounds are the most dangerous; they may easily become infected by poisonous germs introduced with the inflicting instrument, and from the nature of the wound it cannot bleed freely and thus help to eliminate the germs.

In all these wounds, the first object should be the control of hemorrhage; second, thorough cleansing of the wound and removal of all foreign substances—small pieces of stone or coal, grains of fine powder, small shot, etc.; third, careful repair of injuries. Powder may be removed and stains prevented by (under a general anæsthetic) thoroughly scrubbing the affected skin with a stiff nail brush, using preferably some pumice soap, such as "Jumbo." The surface should be scrubbed until it becomes sufficiently raw so that the grains of powder are removed. From time to time during the scrubbing the raw area ought to be cleansed by a non-irritating antiseptic solution. Deeply imbedded grains may have to be cut out. The raw surface should be covered by a non-irritating antiseptic ointment spread upon a protective mask. In a few days the skin begins to repair. Usually, unless there has been a complicating deep burn, very little deformity results. If there has been much dirt ground into a wound it is a wise precautionary measure to given an immunizing dose of antitetanus serum, as the tetanus germs find ready entrance to the medulla along the nerves and the blood stream. A very dangerous though rare form of tetanus follows infection of areas supplied by the cranial nerves, especially in the neighborhood of the supraorbital branches. It is characterized by paralysis of the facial nerve with trismus, and at times by great difficulty in swallowing. A maniacal frenzy is sometimes observed. There may be more or less general tonic muscular spasms.

When the tissues are badly lacerated and more particularly when the wounds are of the punctured variety, careful antisepsis is of the greatest importance in order to bring about repair and the prevention of the formation of scars, the result of healing by granulation. All punctured and other kinds of wounds where infection, particularly with the germ of tetanus, is probably present, should be freely opened,

foreign bodies removed, and the wound cleansed by first using peroxide of hydrogen, because of the anaerobic character of the tetanus bacillus, then thoroughly antisepticized with pure carbolic acid; this should be washed away with 95 per cent. alcohol. Tincture of iodine, or a saturated solution of permanganate of potassium may be employed instead of the carbolic acid and alcohol. All such wounds should be treated on the open, free-drainage plan. The precautionary administration of antitetanus serum is always advisable. If the mucous membrane of the mouth or eyelid is torn or cut, its edges should be joined together separately from the approximation of the torn edges of tissue, skin, etc. The tendency to repair, in wounds of the face, is very remarkable, due to the extreme vascular richness of the skin and tissues; if non-absorbable sutures have been introduced, they may be removed in three to five days. Following wounds of the face, repair may result in considerable deformity and blemish by the adherence of the cicatrix to the underlying bone. Binnie says, "Many otherwise beautiful faces are deformed by the presence of depressed scars adherent to the underlying bone. Sometimes such scars may be neatly excised with gratifying results, but sometimes such treatment is unsuitable or fails. Subcutaneous division of the adhesion between the skin and the bone may do good, but it does not replace the tissues, the loss of which was the cause of the depression. If through an incision the adhesions are thoroughly divided, and if then (after hemostasis is attained by pressure) a suitable mass of fat is gently insinuated through the cut to fill up the depressed area, an ideal result may be obtained. It is best to obtain the fat for transplantation from the patient himself (autoplasty), as homoplasty (*i.e.*, transplantation from another individual of the same species) is not quite so successful and heteroplasty (transplantation from a different species) commonly fails."

Burns of the Face.—Burns of the face are more common than of any other part of the body; the face, being uncovered, is exposed to hot vapors from machinery, from combustible liquids, and from many other causes. These burns deserve special attention; many difficulties are encountered in their treatment and striking deformities often result from cicatrization; one great danger is that of infection of the tissues where they are laid bare by abrasion of the skin. These burns, as in general, vary in degree from the most superficial to deep destruction of the skin and underlying tissues. The pain of superficial burns can be relieved by applying a mild antiseptic ointment such as boracic acid; blebs and bullæ should be opened in a most careful aseptic fashion,

Burns sufficiently deep to cause necrosis or sloughing of the skin are easily infected (a useful and grateful dressing to the patient is balsam Peru *one* part, castor oil *eight* parts); their repair may leave ugly deforming scars unless skin grafting is employed as soon as granulation is well established and before cicatrization has begun. Expecially does this caution apply to burns in the neighborhood of the eyelids, nose and mouth, as contraction from cicatrization not only causes deformity but may interfere more or less with the functions of these parts. Burns by contact with electric wires carrying a high voltage, and also from X-rays (after the separation of sloughs, which is characteristically slow) present pale non-healing granulating surfaces with poor nutritional bases. Grafts placed either directly upon these granulations or upon their bases after curettement, do not "take" readily and repair is very tedious and uncertain.

Infections of the Face.—A furuncle is a common, very circumscribed, painful inflammatory affection of the skin, the point of entrance of the infection usually being a sebaceous gland or hair follicle. The pathological agent is the staphylococcus *pyogenes aureus.* The infection is caused through some slight wound by scratching or irritation, as in an eczema, acne, or sycosis. The importance of the lesion depends upon its location. When upon the lips or forehead serious consequences may follow as complications. It has been observed that furuncles of the face seem to have a predilection for the upper lip and eyebrow. Upon the lip, because of the interlacing of the muscular fibers and the implantation of these fibers into the deep layers of the skin, the infection has difficulty in liberating itself externally and thus extends along the lines of least resistance, the lax submucous cellular tissues, and tends to invade neighboring parts with extensive infiltration which may break down at numerous points, very similarly to a carbuncle. The great danger, however, is that the infiltration is sometimes accompanied by a progressive phlebitis which may spread first from an invasion of the facial vein to the ophthalmic vein, and thence to the intracranial sinuses. An involvement of the cavernous sinus and a fatal meningitis may terminate what at first may have appeared an insignificant lesion. When the furuncle attacks the eyebrow there is early intense tumefaction of the loose cellular tissues of the orbit, and the dangers of intracranial involvement must be borne in mind.

Treatment.—The seriousness of furuncles of the face should be anticipated by early radical treatment. Release of tension and external drainage must be provided by free radiating incisions—the core

should be curetted out. Pure carbolic acid can then be used to mop out the core cavity and incisions. When seen early, the destruction of the center of the furuncle and the indurated surrounding tissues by means of the actual cautery at a dull heat is the best treatment. As the cauterized surfaces tend to interfere with drainage, the actual cautery should be employed only when it can be carried beyond the limits of the infection. To prevent thrombosis of the facial veins they may be ligated about ½ inch below the inner canthus of the eye, as practised successfully by Bullock.

Carbuncles of the face are relatively rare in comparison with furuncles; they are caused in the same way and by the same infecting staphylococcus as the furuncle. They have like characteristics except that there is greater extension of infiltration of adjacent tissues with multiple foci of necrosis and gangrene of the tissues surrounding the infected foci. In the beginning, a furuncle and carbuncle have such similar appearances that they can hardly be differentiated. A carbuncle, from the beginning, is more painful, and there is apt to be a chill and fever. Soon, however, the distinctive, spreading, dusky œdema, with pustules appearing in its central area—each pustule being a focus of necrosis—identifies the carbuncle.

The *treatment*, which is often emolient and tentative when carbuncles appear upon other parts of the body than the face, should, in the latter location, be as thorough and radical as recommended for furuncles; free incisions should be made and curettage done, followed by the application of pure carbolic acid, or preferably the actual cautery. A properly applied actual cautery will cause the infected area to shrink or contract to a remarkable degree.

Malignant Pustule; Anthrax; Wool-sorter's Disease; Charbon are terms applied to a disease which may be quite similar to carbuncle but which is caused by a different germ, the anthrax bacillus. Although not a common disease in America it is occasionally met. The infection is most often seen among workers with animals or hides. The anthrax bacillus produces a lesion very similar to a carbuncle. In the beginning it appears as an irritating papule with a purple center and red base. The papule rapidly changes to a vesicle containing bloody serum, the surrounding redness and induration increases, the vesicle bursts and a yellowish-black scab forms, surrounded by a crop of vesicles similar to the beginning central one. The surrounding vesicles appear elevated above the central scab; there is an extending, dark, bluish, angry-looking infiltration; crops of vesicles form as the infiltra-

tion extends, and gangrene may develop; neighboring lymph glands enlarge but do not suppurate. Although in some instances it may be difficult to differentiate between malignant pustule and carbuncle on the face, a bacteriological examination of the vesicle contents will positively clear up the diagnosis. Great pain is not a feature of malignant pustule. Should the anthrax bacillus be found in the blood, a most serious prognosis is obligatory as this is said to almost always presage death. The bacillus is found in the blood of all fatal cases.

Treatment.—Any wound or vesicle slightly suspicious of anthrax, appearing on the face, as on other parts of the body, should be deeply cauterized with the actual cautery. If a malignant pustule has formed, not only should the pustule area be destroyed with the actual cautery, but the red infiltrated area likewise. The cauterizing iron should be at a dull red heat, the object being not only to destroy all visibly affected tissues, but likewise to extend the heat from the iron beyond the cauterized area, so that any bacilli immediately without the cauterized zone may be killed or inhibited from activity. Excision, radiating incisions, curettage and the after-use of pure carbolic acid, have been successfully employed. In addition the carbolic acid may be injected into the infected tissues.[1] The most painstaking care should be exercised during the progress of the case, against infection of attendants. The patient must be isolated; everyone coming into contact with the subject must be protected by the usual operating-room coverings for the body, head, face and hands. Dressings must be burned and extra care taken in the sterilization of all paraphernalia immediately after each dressing. Not only should the room which was occupied by the patient be carefully scrubbed and fumigated, but all bedding burned as used.

Facial Adenitis.—An important infection has recently been brought to our attention by Lenormant—that of the facial glands. In about 60 per cent. of individuals three groups of glands are found on the sides of the face (Fig. 82) and these at times are the subjects of infection, either acute or chronic. Mascagni first described and figured these glands. But little attention was paid to them until recently, when other investigators in France and Germany pointed out their clinical and pathological importance. The groups of glands are divided according to their location: First, an inferior maxillary group formed of two or

[1] First reliance must be placed upon the local destruction of the infection by the use of the actual cautery and carbolic acid. The serum treatment must never be neglected; Scalvo's serum, in 40 cc. doses, should be injected subcutaneously, preferably in different places in the abdominal wall, or 10 cc. doses may be given intravenously. The serum is harmless, and has been reported to have been followed by recovery in desperate cases.

three glands situated on the external surface of the inferior maxilla in front of the masseter muscle, between the facial artery and vein. This group is sometimes connected with an inframaxillary ganglion situated *à cheval* on the inferior border of each surface of the inferior maxillary bone. A *middle* group is situated upon the buccinator, one part of which (the anterior) is found not far from the angle of the mouth between the facial artery and vein; the other (posterior), near the point

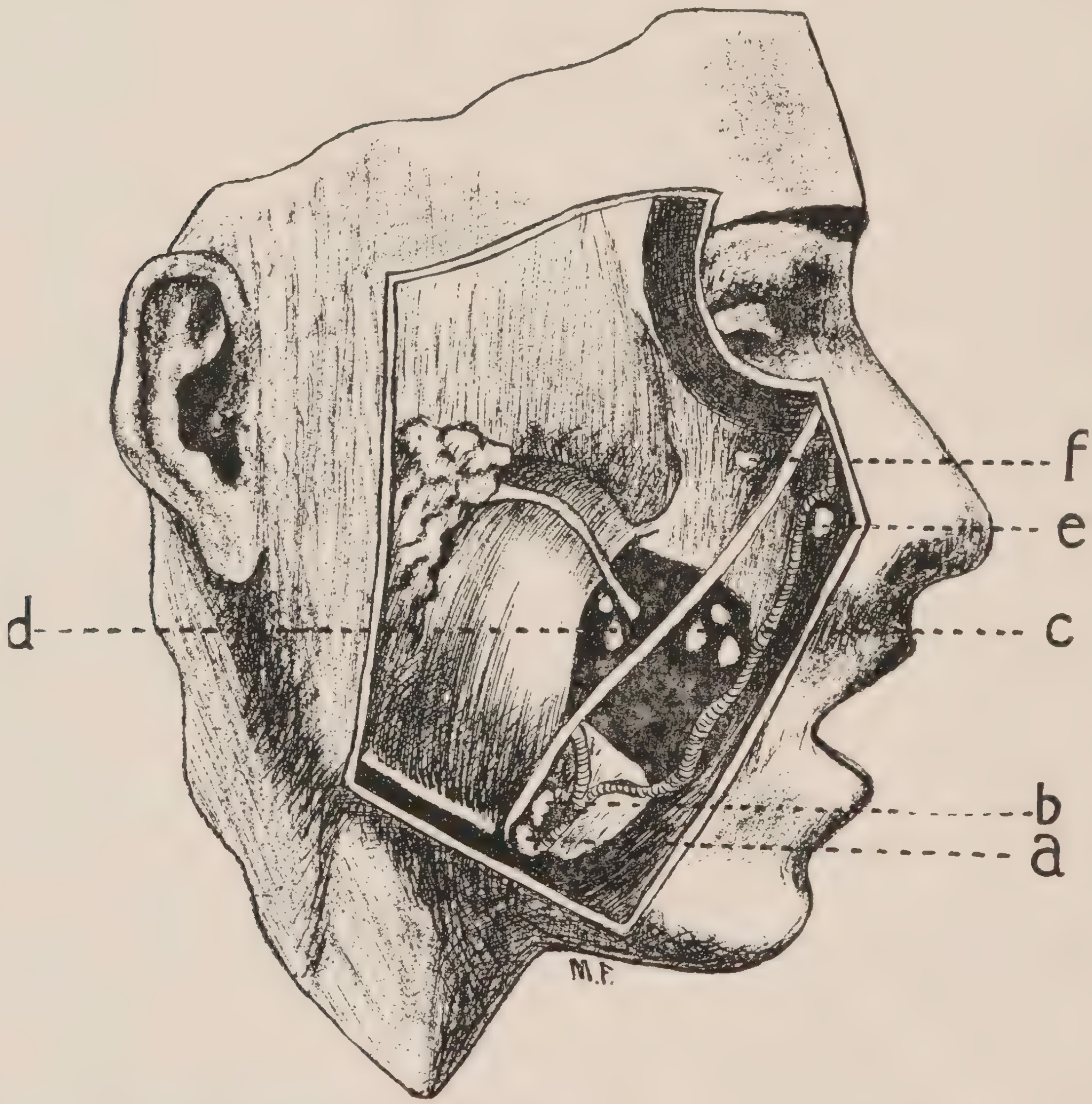

Fig. 82.—Facial glands. *a*, Infra-maxillary gland; *b*, supra-maxillary glands; *c* and *d*, buccinator glands; *e* and *f*, malar glands. (*Buchbinder.*)

where Stenson's duct perforates the buccinator. A third group (the *superior* or malar) is located on the malar process of the superior maxillary bone or upon the malar bone. The superior and middle groups receive lymphatics from the nose, upper lip, the temple, the eyelids and the cheeks, the superior alveolus with its teeth, the tonsils, the pillars of the fauces, and the parotid gland. The maxillary glands receive lymphatics from all of these locations and also from the lower lip. The

facial groups of glands may be the seat of any glandular affection, acute or chronic, following an injury or infection to a cutaneous or mucous area drained by lymphatics into these glands. Any of the locations noted above can be the port of infection. The most common infection is from dental caries, more particularly of the upper molars; infection in these glands is common among scrofulous children.

Trendel, of the Tübingen Clinic, has studied the histories of 87 cases of inflammation of the facial ganglions; among these were a number of personally observed cases. It was noted chiefly that when the adenitis is acute there is more or less pain upon movement of the jaw; the cheek is red and swollen as is sometimes observed in inflammation of the roots of teeth and the gums. Fluctuation, when present, is detected between two fingers, the one placed within the mouth, the other outside; in this way the inflammation can be proven to be independent of the maxilla itself. There may be general symptoms of septic absorption, such as chill and fever. Usually when not interfered with, the suppuration evacuates itself externally through the skin rather than into the mouth. When the infection is chronic, the changes are slow and insidious. When the infection comes from a tooth, a smooth, roundish, movable swelling develops upon the external surface of the maxilla. It is only slightly painful, but may soften, suppurate, adhere to the skin, and open externally with possibly a small fistula resulting. *Tuberculous infection* of these glands sometimes occurs; its history is quite analogous to the chronic form. In malignant disease affecting the parts of the face drained by these glands, they act as do lymphatics and glands in other parts of the body. It is said that only one case of malignancy has been observed having its origin in the facial glands. (Bourgeois-Lenormant.)

Tuberculosis of the face, the different forms of lupus, belong to the realm of skin diseases.

Actinomycosis of the Face.—*Location of Election*.—Actinomycosis is found more frequently on the face than elsewhere. As in the same infection of the jaws, the infecting organism gains entrance through the mucosa, from bits of straw, stems of vegetables, etc., in masticating or holding them in the mouth. An existing ulceration may be the site of inoculation. The disease is found on the cheek, over the inferior maxilla, or more often on the temporo-maxillary part of the face; it is always chronic, usually not continually painful, but may have crises of pain. Early in its history there is muscular spasm (trismus) which is characteristic and continues during the history of the disease. Given

a tumefaction upon the side of the face, neither of a bony hardness nor œdematous nor fluctuating, with normal external skin or mucous covering as it projects into the mouth, the swelling of the soft parts independent of any apparent swelling of the bone, and an absence of glandular involvement—all this, added to the attacks of pain and trismus, should render a diagnosis of actinomycosis probable. Later, when softening and opening of the center of the inflamed areas occurs, the characteristic discharge of actinomycosis, with its parasite, is present. One or several fistulous openings may form.

Treatment.—Iodide of potassium in large, increasing doses is the main reliance in treatment. Surgical intervention should be limited to the period of fistulous formation and, then it should be restricted to favoring free drainage.

The Orbit.—The most common contusion of the orbit, "black eye," usually results from the blow of a fist, but may follow any, even an apparently slight, injury. The looseness of the orbital cellular tissue admits of easy rupture of its blood-vessels with extravasation of blood, and this follows so rapidly that within a few hours of the injury very distinct ecchymosis forms; there may be subconjunctival ecchymosis also. All degrees of swelling occur, up to the complete closure of the eye. Fractures of the orbital ridges and the anterior fossa of the skull may be followed by hemorrhage into the eyelids, conjunctiva and orbital cellular tissue, but the extravasation does not come on within the first few hours as in simple "black eye;" it gradually makes its appearance during the 24 to 72 hours following the injury.

Treatment.—Hot-water compresses applied for several hours followed by a firm bandage, preferably an elastic one put on over a sufficient-sized wad of absorbent cotton, will tend to limit extravasation and hasten absorption of the effused blood.

Wounds of the Eyelids.—Wounds of the eyelids are not uncommon and are of importance according to their depth and direction. When superficial and in the direction of the fibers of the orbicularis muscle, they do not gape and they heal kindly. Vertical wounds gape widely. Horizontal wounds may require suturing, but this is usually unnecessary unless the wound is deep and the levator palpebræ superioris tendon is divided. In such an instance the divided ends should be sewed together with fine catgut and the skin wound closed with a few interrupted stitches. Deep vertical wounds require not only buried catgut sutures but in addition supporting silk stitches passed deeply and at some distance from the wound edge so as to render good

support to the buried sutures, as there is apt to be considerable swelling unless the inflicting instrument was a keen-cutting one.

Tumors of the Eyelids.—The tumors of the lids which are of especial interest to the general surgeon are the angiomata, sarcomata, and carcinomata. *The angiomata* are either of the teleangiectatic or cavernous type; they are usually observed shortly after birth and may grow rapidly. Should they show this tendency, early removal is desirable. This can be accomplished with the galvano-cautery needle. The

FIG. 83.—Enlarged, rapidly growing angioma of the upper lid and forehead.

FIG. 84.—The same case after treatment by injection with alcohol. (*By Dr. H. B. Lemere.*)

cavernous tumors should either be destroyed by electrolysis or, if small, they may be excised. If large and growing rapidly (as in Fig. 83) they are best destroyed by injections of absolute alcohol, 30 to 40 minims injected at intervals of from one week to two months; Fig. 84 shows the result of this treatment.

Sarcoma of the lids is usually of the melanotic type (melanosarcoma); it is chiefly found in children and young people but may be found at any age; its occurrence is rare. The growth begins as an elastic circumscribed swelling in the connective tissue. As it infiltrates the skin, its melanotic color becomes apparent. The skin breaks down, forming an ulcer with bluish-black edges and base. The growth may

extend to the globe and orbital tissues. Early radical removal is the only treatment (Fig. 85).

Carcinoma of the lid is, as a rule, of the slow-growing epithelioma type of ulcer; the base and edges are irregular and infiltrated, repair taking place at one part while the edge breaks down and the ulcer

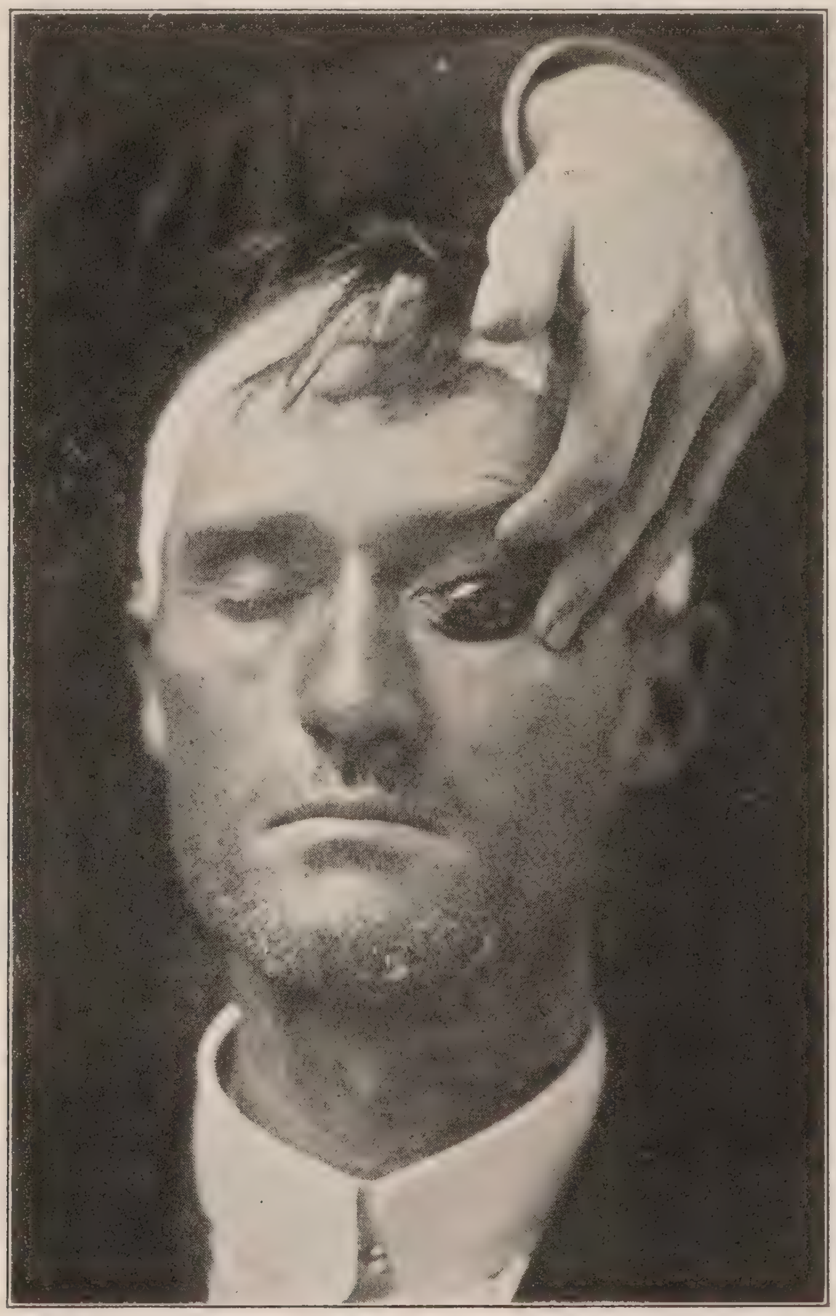

FIG. 85.—Melano sarcoma of the lid. (Patient of Dr. H. Gifford, operated on successfully.)

spreads at another part. The X-ray and radium hold the first place in the treatment of these ulcers, while escharotics are also useful. These methods of treatment are preferable to the knife which, to be successful, must cut wide of the ulcer edges, and plastic work may be necessary to restore a proper covering for the eye.

Punctured Wounds through the Orbit.—Clinically, these injuries seldom occur except through the orbital plate of the frontal bone. A very few cases have been reported of the puncturing instrument entering through the nostrils. An instrument may be driven through the skull at any part and wound the brain. A considerable variety of instruments have been known to penetrate the brain by way of the thin orbital plate of the frontal bone, the most common having been umbrella sticks, canes, pieces of wood, narrow-bladed instruments of warfare, etc. The eye not uncommonly escapes injury when the entering instrument fractures the orbital plate near the superior orbital fissure. In such cases, the wound first passes through the upper eyelid. A part of the puncturing instrument may remain in the brain. The injury to the brain is usually confined to the frontal lobes, but may involve other parts. If the brain is punctured through the optic foramen, the eye is almost certainly injured, and the optic nerve is necessarily crushed or divided unless, perchance, the puncturing instrument is of very small diameter, like a hatpin. Besides any injury to the eye which may complicate these accidents, the main danger lies in the brain lesion; not so much usually from the immediate destruction of brain tissue as from secondary inflammatory processes.

Hemorrhage may be sufficient to produce dangerous pressure symptoms, but this will hardly occur unless the injury is through the floor of the orbit toward the vessels at the base of the brain.

Treatment.—The treatment of these injuries should be directed toward an exposure of the injured parts sufficiently extensive to enable the surgeon to carefully examine for the presence of a foreign body, when, from the history of the case, such a body may have remained in the wound. The surgeon should not limit his interference until he has cleared a passage for careful inspection and drainage of the injured brain. Although it may be necessary to boldly open up the skull in front of and above the track of the wound, usually it will suffice if, after shaving the eyebrow and using the usual aseptic precautions, the orbital plate of the frontal bone is exposed by making a free curved incision along the upper edge of the orbit down to the bone, separating the loose cellular tissue, and depressing the globe with a small flat retractor. By this means sufficient space will be secured for the exposure of the wound. With small chisels the opening through the bone is enlarged sufficiently to explore the wound and provide for drainage. The accompanying photograph (Fig. 86) is of a child who had fallen upon a rusty, dirty button-hook with which it had been

playing. The hook had, in some manner, rotated so that it was necessary to remove considerable bone before it was extracted. The writer followed the practice just recommended and recovery was entirely satisfactory. Should the brain be punctured through the optic foramen, the eyeball must be removed to admit of proper exploration and drainage. In such a case, even if the globe of the eye is not injured, the optic nerve probably is, and in any case it is better to sacrifice the eye than to invite secondary inflammatory conditions in the orbit and maybe in the brain. A good general rule would be that, in all cases, the bottom of the wound should be explored and drained by the most direct route, preserving the integrity of an uninjured eyeball when possible. If the eyeball is wounded and probably infected, it should be removed. The inflammatory swelling of the loose connective tissues of the orbit is a source of great danger. The swelling

Fig. 86.—Punctured wound of the brain through the orbital plate of the frontal bone. (From a patient in the Clarkson Hospital.)

interferes with drainage, and infection may pass along the track of the wound to the brain. When practicable, the counsel and assistance of an expert oculist should always be sought in the treatment of these complicated injuries. In those rare wounds of the brain through the nostrils, the base of the brain should be freely exposed by making an opening through the frontal bone. Most painstaking antisepsis must be employed so as to limit probable infection derived from the nasal cavity.

Abscess of the Orbit (*Cellulitis*).—Infection of the cellular tissue of the orbit may result not only from injury and the presence of foreign bodies, but also from inflammations having their starting point about the teeth or upper jaw, the nasal fossæ and the neighboring sinuses. It is sometimes a complication of facial erysipelas; it also may be secondary to infections of the conjunctiva and eyeball itself (Fig. 87).

Symptoms.—There is marked swelling and œdema of the conjunctiva

and eyelids; as the inflammation progresses the lids become a dusky red, and this signifies the beginning or presence of suppuration, which is the usual termination. In most severe cases the constitutional symptoms are marked, with rigors, high temperature, rapid pulse and severe pain.

Treatment.—As the dangers to be feared are first, spread of the infection to the meninges, and second, destruction of the eye, early interference is indicated; this consists in making an incision through the

FIG. 87.—Orbital cellulitis, secondary to ethmoiditis. (Patient of Dr. H. Gifford.)

conjunctiva at the palpebral fold, and passing the knife backward in such a manner as not to injure the globe, the idea being to establish drainage as early as possible. In more advanced cases where there is great swelling, it is wiser to make the incision through the lid at the orbital margin, and then to introduce a suitable-sized curved forceps in such a way as to avoid injury to the globe. After pus has been reached the forceps blade is opened as the instrument is withdrawn, thus enlarging the drainage tract, which should be kept open by proper-size tubing. Hot boracic fomentations should be used and no pains

spared to keep the drainage free. Infections of the eye itself call for evacuation of the globe, and possibly later enucleation.

Tumors of the Orbit.—Tumors of the orbit arise from the orbital tissues themselves, or from the bony walls or neighboring sinuses, involving the orbit secondarily. When the tumor is *fluid* its origin is usually from the frontal sinus or the ethmoid. The fluid is either mucus or muco-pus. Fig. 88 illustrates a benign tumor of the orbit,

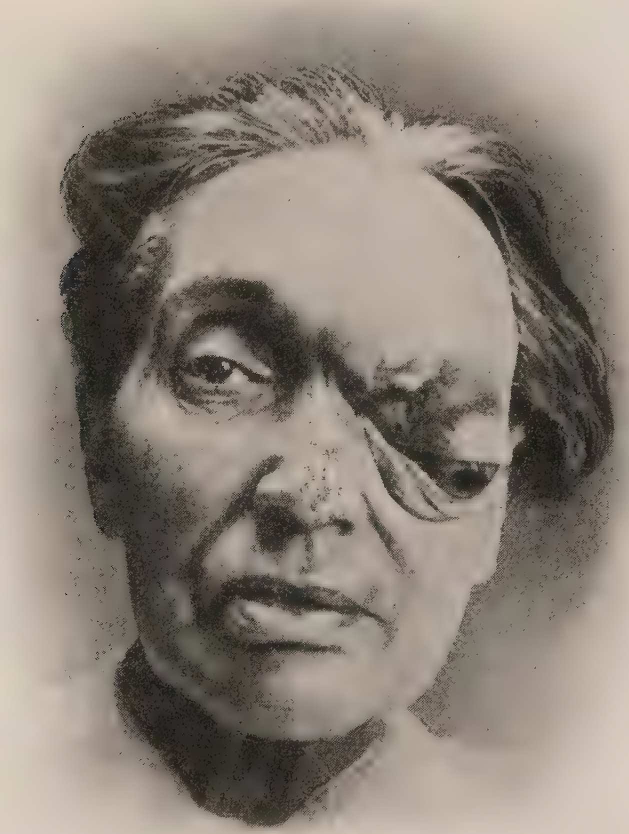

Fig. 88.—Frontal mucocele of three years' standing, causing dislocation of the eyeball. (*British Journal of Surgery, April*, 1914.)

having its origin in the frontal sinus. Distinct egg-shell crackling could be obtained over the surface of the tumor. This identified its cystic nature. It was operated on successfully. *Solid* tumors, originating in the soft tissues of the orbit, are almost always malignant. In children they are exceedingly malignant and commonly gliomata; they may be bilateral. In older people they originate in any part of the globe. When the tumor begins in the pigmented structure of the globe it takes on melanotic characteristics.

Exophthalmos is usually present and the direction of the protrusion

is generally away from the location of the tumor (Fig. 89); there is limitation of motion and some ptosis, and diplopia will probably be present if there is much displacement. The intraocular tension is increased, the pupil is dilated, and blindness follows; the lids become œdematous. Solid tumors cannot be pressed back into the orbit;

FIG. 89.—Solid tumor of the eye—glioma. Exopthalmos; tumor located towards nasal side of orbit. (*H. Gifford.*)

cystic tumors can, to a slight degree. Because of the inability of the lids to protect the cornea, ulceration may take place. A solid tumor arising from the bony walls of the orbit is an osteoma; it occurs usually in persons under 25 years of age, has a sessile base and produces eye symptoms according to its size and location. This tumor seldom be-

comes malignant. Numerous kinds of cysts are found in the cellular tissue of the orbit, among them a congenital encephalocele passing from the brain through the suture between the ethmoid and frontal bones. Its growth is rapid; it may or may not pulsate; the eye becomes displaced. A pulsating orbital tumor is commonly an aneurism of the ophthalmic artery. Often the pulsation is caused by an arteriovenous aneurism, or a connection between the carotid and the cavernous sinus. These tumors must be differentiated from the tumors of a malignant type rich in blood-vessels—telangiectic sarcomas. As the aneurism grows, exophthalmos develops and one can see and feel a distinct systolic pulsation. The patient hears the purr of the aneurism (Dyball). Compression of the common carotid causes a disappearance of the pulsation.

Treatment.—If a pulsating orbital tumor is of rapid growth and the discomfort is sufficient to justify the risk, the internal carotid on the same side should be tied. A cure must not be promised as the symptoms may return; should the recurrence take place, the remaining internal carotid may be tied. An *osteoma* should be exposed by a suitable incision and removed, after chiseling through its base. The congenital *encephalocele* is inoperable; life is usually terminated in the first four to eight months. The removal of *gliomata* in children is usually followed by recurrence, even when operated upon early. All tumors of the orbit should be removed as early as possible.

Tumors of the Face.—The face is a favorite seat for epitheliomata; warts, moles, chronic inflammations or ulcerations are the chief predisposing factors. It is sometimes difficult to recognize the beginning of a carcinomatous growth. The formation of crusts which reappear when removed from a granular bleeding surface, the gradual extension of the ulceration with indurated and raised edges should always arouse the suspicion of malignancy. The involvement of the regional lymphatic glands may be an early or late complication, depending upon the degree of malignancy of the primary growth.

Treatment.—As in all other malignant affections, a timely diagnosis and a radical excision of the diseased area, including a liberal margin of adjoining tissues, offers the only hope of a permanent cure. Rapidly growing epitheliomata with metastasis to the local glands, although not flatteringly hopeful as to operative cure, should be excised, removing as well as possible all of the growth and glands together, and cauterizing with the actual cautery the edges and bases of the wound. Cures by the X-ray and radium of chronic slow-growing epitheliomata are from

time to time reported, and the intelligent use of escharotics certainly has a place in the treatment of the less malignant types of growth.

Carcinoma of the Lip.—Cancer of the lower lip is frequently observed; the upper lip is seldom the seat of a primary cancer and women are singularly free from this form of cancer.

As is the case elsewhere, cancer of the lip follows some irritation. A pressure irritation or blistering in a tobacco smoker from a hot pipe-stem, is a well-recognized cause. The disease occurs in people at or beyond middle age; usually it begins on one side, at the muco-cutaneous border, as a blister or burn; there is a "small depressed area, dark in color and of leathery consistency. This dark area cannot be picked off as a scab." Later a scab forms which can be picked off leaving a slightly bleeding surface. Induration begins to develop around and beneath the scab, and sooner or later an ulcer forms. This ulcer may heal and again break down with a tendency to slowly spread. After the ulcer forms, it may spread rather rapidly until a greater or less part of the lip is involved, sometimes extending around the angle of the mouth and attacking the upper lip (Fig. 90).

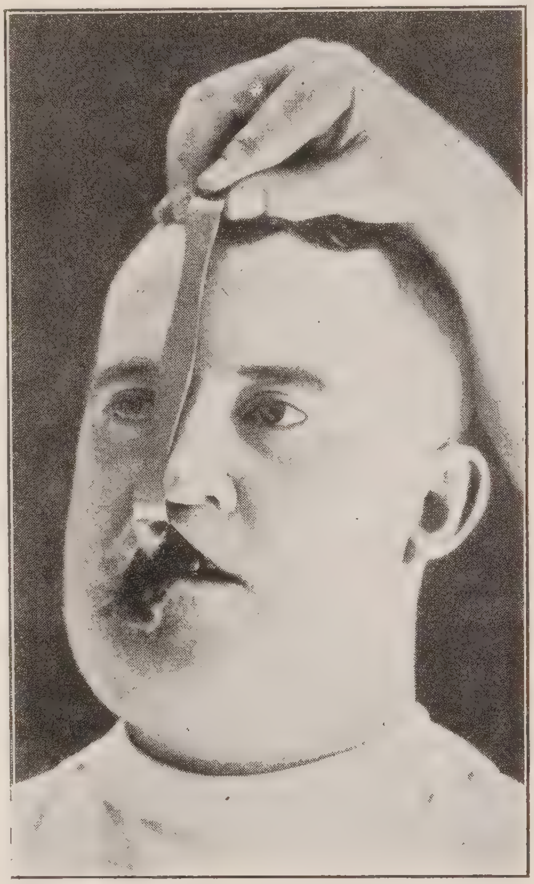

Fig. 90.—Carcinoma of the lower lip, extending around the angle and attacking the upper lip.

Usually within three months from the commencement of the formation of the ulcer the submental, submaxillary and cervical glands become infected with cancer, the involvement occurring in the order named, although they may not be palpable. On the other hand, the glands may early enlarge from septic absorption, before cancer infection has invaded them.

Although the progress of the formation of the ulcer may be very slow, sometimes lasting a year or longer, yet after the ulcer is developed the glands are already, almost without exception, invaded by the cancer germs. As the ulcer spreads, it eats into and destroys the lip, coverings of the chin, and often there is a large, foul, ulcerating mass, involving the floor of the mouth, the infected glands, and even the lower jaw.

Death occurs from pain and exhaustion, or from hemorrhage; the disease lasts from commencement to end three and even five years.

Cancer of the lip can hardly be mistaken for any other lesion. In the earliest precancerous stages the lesion is local. Out of 200 cases (Bloodgood, Surgery Gynecology and Obstetrics, April, 1914), 15 were microscopically found to be benign. Warts, either benign or malignant, may grow upon the lips; they follow injuries such as a razor cut, the habit of frequently biting the lips, smoker's burn, wounds of some kind, blisters, etc. The malignant warts are larger than the benign and usually ulcerate both at the surface and at the base. "A wart on the lower lip larger than the end of the index-finger was always microscopically malignant, but smaller warts have been microscopically

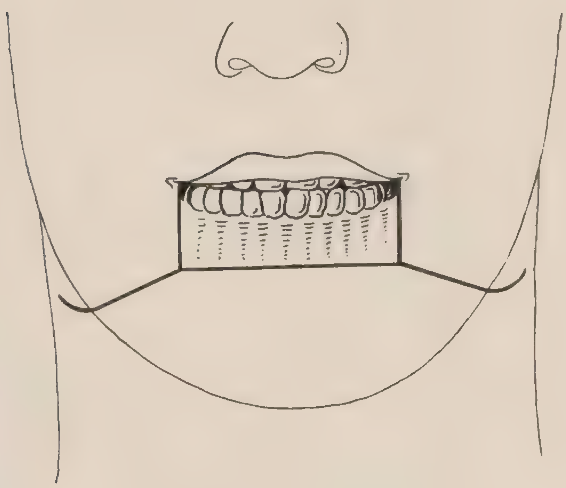

FIG. 91.—(*Grant.*)

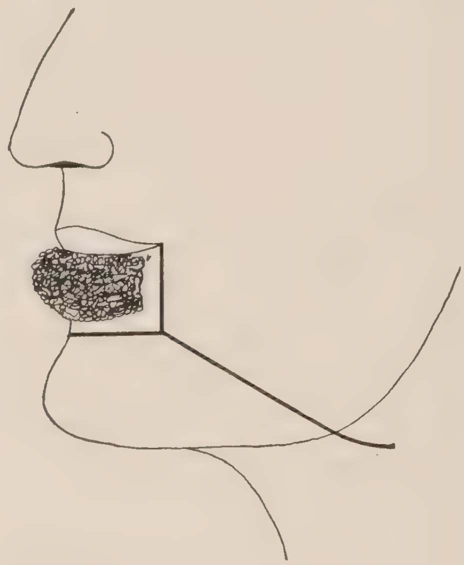

FIG. 92.—(*Grant.*)

malignant." A cancerous ulcer of the lip can hardly be mistaken for any other lesion although chancre of the lip must be reckoned with; however, the fact that chancre may occur at any age, the history, the acute character of the ulcer, the early lymphatic involvement, the appearance of secondary symptoms, the discovery of the spirochæta pallida, the positive Wassermann reaction after the appearance of the secondary symptoms, and the early healing of the ulcer under the administration of antisyphilitic remedies, including Salvarsan, will differentiate the ulcer. Gumma of the lip is rare; its rapid disappearance under the administration of iodide of potassium and mecrury alone or with Salvarsan, positively differentiates it from cancer—besides, when not irritated there is an absence of pain and glandular enlargement.

Treatment.—The successful treatment of this curable, common form of cancer depends upon two things: *one*, the earliness with which the

lesion is detected, *the other*, the thoroughness with which it is removed. Experience demonstrates that although the lesion may be detected early (within three months of its beginning) and the growth, with a wide margin of normal appearing tissue, be removed, yet later glandular involvement develops, proving that even in seemingly local lesions it is not wise to refrain from the removal of the glands. Bloodgood reports one late infection (after five years) out of 10 cases in which the lesion was less than three months old. Excision of the lesion of the lip and glands in which there was no apparent metastasis in the glands, resulted in twenty cures among 21 cases. On the other hand, when the same procedure was carried out, there being present, however, a metastasis in the glands, out of 12 cases there were six cures—

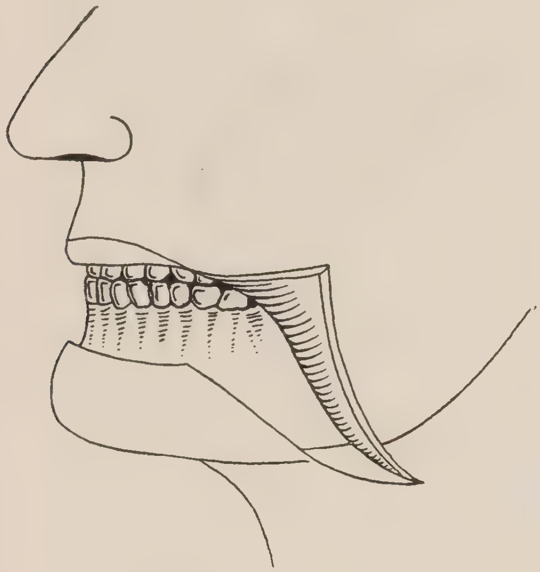

FIG. 93.—(*Grant.*)

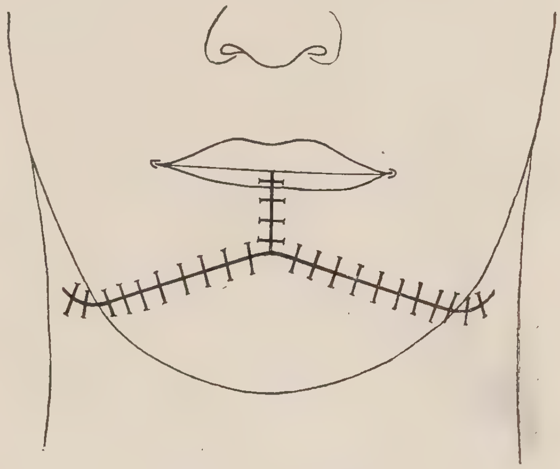

FIG. 94.—(*Grant.*)

recurrence in the glands of the neck took place in five, and in one the recurrence was local. Of the five gland recurrences, there was only one cured by farther operation.

All of this goes to demonstrate a rule of practice from which there should be no possible exception—radical removal of the primary lesion and also of the glands in direct line for metastatic infection. Any habit or occupation which has caused to form a recurrent local lesion upon the lower lip, which is demonstrable, and this lesion disappears upon the giving up of the irritating cause, need only mean a warning that a persistence in the habit of irritation *may* result in cancer at the site of irritation. A little lesion or ulcer, if it does not disappear after removing the cause of irritation and employing *bland local treatment*, should receive careful consideration as to operative treatment. Caustics and irritants of all kinds are more than contraindicated; they are *dangerous*.

Operation.—Numerous incisions have been devised for the removal of the growth and for the excision of the submaxillary lymph glands. The operation that best meets these indications and at the same time admits of closure of the incisions so as to give a useful and relatively natural appearing mouth is, in the judgment of the writer, that devised by W. W. Grant of Denver, Col. "Two perpendicular incisions are made on each side of the growth, connected by a straight transverse incision at the base, which is usually about the crease between the chin and lip. This leaves a quadrangular space to be filled by flaps. An incision is now made from each inferior angle of the wound, obliquely downward and backward beneath the maxilla, on a line about equi-

FIG. 95.—(*Grant.*)

distant between its angle and the apex of the chin or symphysis. (Figs. 91, 92, 93, and 94.) Its further extension is measured by the extent of lip removed and the glandular involvement. All the submaxillary glands are removed through these incisions except the submental, which may necessitate a separate incision in the middle line. When the lip is extensively involved, the cheek is completely separated from the inferior maxilla to the middle of the masseter muscle. After the glands are cleaned out the triangular flaps are brought together and united first in the middle line. If the tension is great or considerable, from the amount of tissue excised, one mattress suture should be inserted about three-quarters of an inch from the central line, and tied over pads of gauze, covered with oiled muslin to prevent soiling. This

effectively removes undue tension from the sutures in the center of the flaps. The stitches uniting cheek posteriorly are now inserted, or if previously inserted are tied, care being taken to include the entire thickness of cheek or upper border. For this purpose interrupted silkworm-gut or a running stitch of chromicized catgut is used. A small rubber tube should be inserted in the posterior angle of the wound on each side, to drain the mouth and for irrigation purposes. A T-drain, size of a lead pencil, should also be inserted through the submental space to the mouth, beneath the tip of the tongue. This is important.

The stationary chin tissue is of the greatest importance as a point of fixation for the flaps. In uniting the flaps to the chin in the centers it is well to omit a stitch for drainage of the space between incisors and

FIG. 96.—(*Grant.*)

flaps. When half or more of the entire lip is removed, the operation is perfected and completed by making an incision from each angle of the mouth backward and slightly downward half to one inch in length, down to the buccal mucous membrane, which is then separated from the overlying tissues above, below and posteriorly, to the extent of half an inch. The lip above and below is now beveled from the inner border in order to conform to natural conditions and also to make it easier to cover. The mucous membrane is now divided in the middle line and the flaps are united to the skin by one continuous suture of chromicized catgut."

Rodent Ulcer.—Rodent ulcer, a chronic form of carcinoma, is seen with especial frequency on the upper two-thirds of the face—the skin

over the maxillary antrum and inner and outer canthi being the chief seats of election. It usually occurs after the age of 40, begins as a painless papule or wart, which in the course of 8 or 12 months may reach the size of a split pea. This knob may remain stationary for months or years, but sooner or later begins to ulcerate and form crusts —an evidence that the disease is becoming more active. A few months following the beginning of crust formation the ulcerative process begins to extend marginally and to the deeper structures. It grows increasingly, slowly spreads, destroying everything that it meets, including bones, and producing hideous deformity. This destructive process may go on for years, the general health remaining fair. At times the ulcerating area shows a limited cicatrization which, in the course of time, again breaks down. There is but little discharge from the ulcerating surface. The ulcer has a depressed irregular surface with a more or less indurated rolled-over edge. Neighboring lymphatic glands are not involved and no metastasis occurs. Etiologically, rodent ulcer is a form of cancer having its origin in the sebaceous or sweat glands. Histologically, it is made up of columnar-shaped cell nests containing rather small epithelial cells.

Treatment.—Early operative interference is necessary. A careful and liberal removal of a good margin of healthy tissue along with the lesion, holds out encouragement for a permanent cure. The defect resulting from the excision is to be made good by skin grafting on a granulating surface about 6 to 12 days following the primary operation. The X-rays have a remarkable inhibitive influence on this growth and in a considerable number of cases permanent cures result. The X-ray is used daily for 10 minutes; after a week's application, local inflammatory reaction follows. The treatment is kept up for three or four weeks. A clearing up and healing very frequently follows in several weeks. If there be a recurrence, treatment is repeated. Radium has proven most satisfactory, and conclusions from recent reports indicate that it may become the treatment of choice.

Sarcoma.—Primary sarcoma originating from the soft parts of the face is exceedingly rare. Most sarcomata of the face have their starting point from the deep parts, bones or parotid glands. Congenital sarcomata develop from the soft parts of the face, grow rapidly soon after birth, produce early metastasis, and terminate life generally within the first 18 months. Histologically, they are usually angiosarcomata or myxosarcomata. Sarcomata which develop later in life present the appearance of a multiple mass of papillomata. The predominating

type is the melanotic variety, nodular or papillary in form, and showing dark pigmentation. The tumor is slowly progressive; regional lymphatics become involved and later systemic metastasis occurs. The prognosis of sarcomata, particularly of those developing soon after birth, is unfavorable.

Treatment.—Early radical removal, while the tumor is single and localized, should be done. Diffuse local infiltration and lymphatic involvement is a contraindication to operation.

Angioma.—Angiomata are vascular tumors. If the constituent vessels are blood-vessels the lesion is designated "hæmangioma." Several varieties are recognized—the simple and hypertrophic forms being most common. *Angioma simplex*, also known as birth mark, appears as a dark red, port wine, or bluish discoloration of the skin without elevation of surface. Such tumors vary in size from a small speck to an involvement of a greater or less part of the face, are limited to the skin and are usually observed at birth or appear a few weeks later. They may remain stationary or grow to considerable size. The skin involved is usually smooth and bleeds profusely when injured. Pressure drives the blood from the vessels, the color immediately returning when pressure is removed. These tumors are benign and cause no symptoms. Patients afflicted with them often shun publicity and society on account of the conspicuous discoloration.

Treatment.—External applications or compressions are useless. Galvano-puncture is a simple valuable treatment for small nævi. The technique of its application is fully given in works on medical electricity. The injection of 1 to 2 cc. of boiling water, forced through a large-sized hypodermic needle and injected at several places, produces absorption of blood pigment and formation of fibrous tissue. Injections should be repeated each three to four weeks until all parts of the tumor have been reached. The subsequent cosmetic results are usually satisfactory. The best results are obtained by a radical excision of the discolored mass followed immediately by a plastic operation. A suitable flap with attached pedicle is obtained from the arm as in the Italian rhinoplasty. Excision followed by immediate or later skin grafting is also practised.

The hypertrophic forms of hæmangioma appear as distinct local swellings, lobulated tumor-like growths of soft elastic consistency, with a bluish or red overlying skin. The majority of this class of tumors exist at birth or develop within the first few weeks. Growth is rapid for a time but the tumor finally becomes stationary. The upper lip is

the chief location of these tumors. Secondary changes, as hemorrhage, ulceration, and inflammation are frequent. Histologically, these tumors are made up chiefly of convoluted blood-vessels with a relatively small amount of interlobular tissue.

Treatment.—Treatment consists of radical excision performed within a few weeks after birth, especially when the swelling is of a progressive character; this treatment is advisable only when the tumor is very small. At times the tumors grow very rapidly and a late removal would sacrifice considerable tissue and result in permanent disfiguration. In these circumstances the best treatment is the injection of hot water, as in simple angiomata, or injection of absolute alcohol as recommended for similar tumors of the eyelids.

Lymphangioma.—Tumors in which lymphatic channels predominate are occasionally seen about the upper or lower lips at birth, or they may develop afterward. As a rule, they appear in the form of a diffuse swelling leading to a hypertrophy of the involved lips, a condition commonly known as "macrocheilia." The consistency of the tumors is variable, depending upon the amount of fibrous tissue. They grow slowly and as a rule progressively. The overlying skin is usually adherent to the deep parts.

Lymphangiomata may develop from any part of the face, and occasionally lead to considerable deformity. The tumor is readily differentiated from hæmangioma in that the overlying skin shows no discoloration. A great many *angiomas* are congenital and apparently they develop in the line of embryonic fissures; they have been called by Virchow, "fissure angiomas." The congenital origin of lymphangiomata is more frequent than that of the hæmangiomata. They have been observed on the eyelids, the cheeks, and the lips, particularly the upper lip.

Treatment.—Well-defined tumors can readily be excised. The diffuse and infiltrating variety offers considerable difficulty in so far as a complete removal is concerned, with subsequent cosmetic results. Partial excision usually leads to progression of the growth unless followed by chemical or thermic cauterization of the marginal remnants.

Lipoma.—Tumors of the face in which fatty tissue predominates, are very infrequent. They are usually well defined, encapsulated, single or lobulated, the overlying skin being freely movable. The mixed forms, such as the fibrolipomata and angiolipomata, as a rule, are not encapsulated but have a diffuse position in the tissues. The

growth of these tumors is very indefinite. They often enlarge slowly and finally become stationary.

Treatment.—On account of the disfigurement caused by their presence, removal is usually sought.

Dermoids.—Dermoids are exceedingly rare about the face. The margin of the orbit, inner canthus, and root of the nose are the seats of election. The majority of these tumors are noticed during early childhood in the form of slow-growing, semi-fluctuating nodes. The overlying skin is not adherent unless the cyst becomes infected. Dermoids contain a caseous fatty material and hair. An opening into a dermoid cyst results in a dermoid fistula which discharges sebaceous material; projecting hairs are often visible.

Treatment.—Realizing that the contents of dermoids is the result of encased epithelial cell activity, the cyst having skin for its inner lining, successful treatment must accomplish the complete removal of the cyst wall.

Sebaceous cysts are usually situated near the scalp.

Treatment consists in removing the wall by dissection.

Cutaneous horns are local wart-like projections having for their base hypertrophied papillæ which are covered by a thick layer of cornified epithelium. The base must be removed with the horn, or the latter will recur.

Actinomycosis (*Lumpy Jaw*).—*Etiology.*—This affection is caused by the fungus known as *actinomyces bovis*, and is a disease most common among cattle. The source of human infection is not definitely known but is supposed to be introduced through infected vegetables, as in chewing certain cereals the buccal tissues may be punctured by a barley or wheat spikelet. In many cases carious teeth seem to be the seat of primary infection and the case is mistaken for an ordinary dental affection. The lower jaw is most frequently involved. The disease is chronic, resembling sarcoma in its clinical features and in its anatomical location, and it is not infrequently diagnosed as such; it usually begins in the gums as a local indurated swelling which slowly extends to the neighboring soft parts and bones. An alveolar abscess may coexist. The induration and swelling is slowly progressive, the tumefaction presenting an uniform or nodular enlargement of board-like hardness, not tender to pressure. The disease runs a painless chronic course with no tendency to spontaneous recovery, and in the course of years the enlargement may be so great as to cause much disfigurement of the face. Lymphatic glands show a late involvement.

Untreated, the disease usually extends and in time proves fatal. Leukocytosis and elevation of temperature are absent unless acute secondary pyogenic infection is present. During the progress of the affection small actinomycotic abscesses form; these periodically open on the skin or buccal surface and discharge a purulent material containing yellow granules about 1/40 inch in diameter. The granules, when pressed between a slide and coverslip and examined microscopically show a central hyaline area with radial striations. Histologically, actinomycosis is a chronic productive inflammation.

Treatment consists in excising and curetting the diseased tissue, in adequate drainage and in the internal administration of potassium iodide, in doses of 5 to 10 grains, three times daily; the dose is gradually increased until 60 to 120 grains are taken daily. After two months, copper sulphate is substituted in doses just short of the nauseating point, and after five to eight months potassium iodide is again given.

Tuberculosis.—Tuberculosis of the maxillary bones is rare. It may be primary or secondary. The primary form usually occurs in the lower jaw and manifests itself as a chronic indurated swelling, slightly tender to pressure and practically painless. The tuberculous process may form fistulous openings through the overlying skin, discharging caseous, purulent material. Regional lymphatic glands are enlarged. It is differentiated from a sarcoma in that the latter is more rapid in progress and does not involve the lymphatic glands. Sometimes, however, exploratory excision is necessary for diagnosis.

Treatment.—Treatment is along the same general lines as in tuberculous osteomyelitis elsewhere. Especial care should be taken to avoid the formation of any communication between the tuberculous areas and the buccal cavity as secondary infection is particularly to be avoided. *Secondary tuberculous affections* of the jaws appear in the form of alveolar abscesses in patients suffering from pulmonary tuberculosis. Mixed infection is always present. The teeth involved should be extracted, the cavity curetted and the mouth kept clean with antiseptic washes.

Osteomyelitis.—Osteomyelitis of the jaws may be primary, originating from the circulation or secondary by extension of infection from without, as in compound fractures, or by extension from the soft parts. That the maxillary bone offers a natural resistance to infection is evidenced by the fact that with the innumerable extractions of teeth an atrium of infection is produced, and yet infection of the bone does not

occur. However, an alveolar abscess (submucous, or a gumboil, D Fig. 97, or a monoarthritis at the apex of the tooth, A), if untreated may lead to diffuse osteomyelitis. The foci, (B and B′), originate from A; from these in turn develop subperiosteal abscesses (C and C′). If the focus of osteomyelitis is above the level of the gingival mucous membrane (B), then a mucous fistula (N) forms; on the other hand, if the focus is below the gingival mucous level—as often occurs on the outer side of the jaw—a cutaneous fistula (M) will form. Infection is most common in the lower jaw, is usually of the acute type and may

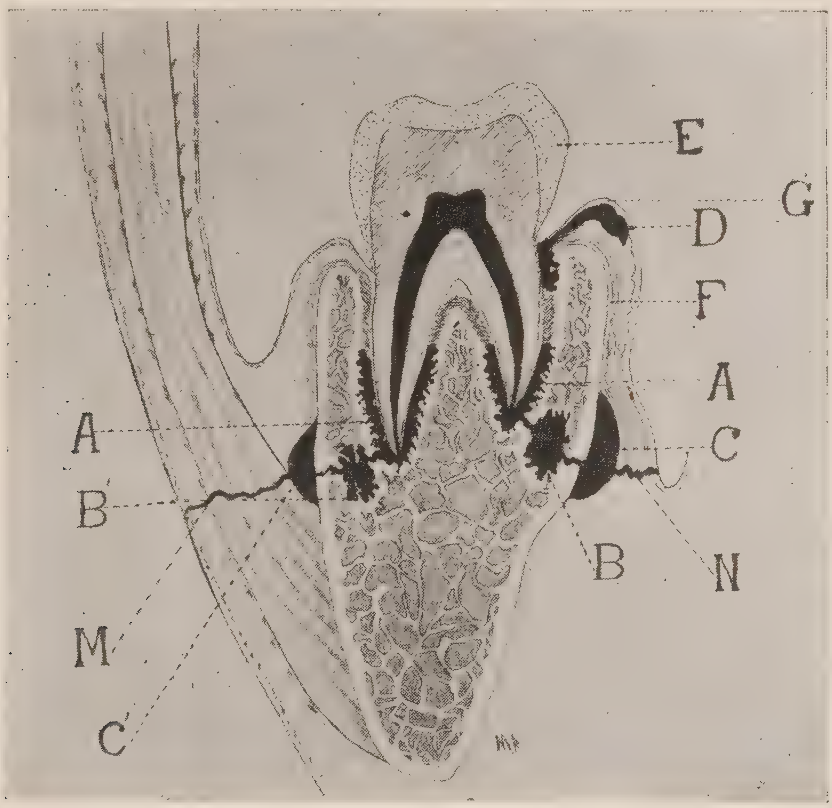

FIG. 97.—*D*. Gumboil; *A*, monoarthritis at apex tooth; *B*,*B′*, foci osteomyelitis; *C*,*C′*, subperiosteal abscess; *N*, mucous fistula; *M*, cutaneous fistula.

lead to extensive necrosis. Clinically, it is characterized by pain, swelling, extreme tenderness, and symptoms of intoxication.

Treatment consists in exposing the diseased areas, removing sequestra and establishing adequate drainage.

Periostitis.—Periostitis, an inflammation limited to the periosteum, is rare. *Osteoperiostitis* is a more fitting term, denoting an inflammation of the periosteum and the subperiosteal bony tissue. It is usually secondary to dental caries, acute in onset, with pain, tenderness, and swelling as the main features.

Treatment should be directed toward draining the primary focus. Hot fomentations are useful and gratifying to the patient. If swelling is very marked, with evidence of pus formation, incisions are indicated.

Pyorrhœa Alveolaris (*Riggs' Disease*).—Pyorrhœa alveolaris consists of a chronic inflammatory condition of the margin of the gums in their relation with the alveolar periosteum and the necks of the teeth. It is a septic infection thought by some to be the result of auto-intoxication due to intestinal stasis. It is characterized by an accumulation of tartar between the edges of the gums and the teeth, whence a mucopurulent discharge escapes. Atrophy of the alveolar border and gums takes place, with consequent loosening of the teeth, which may fall out. Only a few teeth may be involved but usually the disease spreads until nearly all, if not all, are attacked. It is very seldom seen in people below middle life.

Treatment.—The tartar should be removed and the spaces between the necks of the teeth and the gums mopped out with strong solutions of nitrate of silver, tincture of iodine, or some other reliable antiseptic. Solutions of chlorate of potash and thymol as mouth washes, together with the most scrupulous use of dentifrices and the sterilized tooth brush, afford the best means of local treatment. Thoroughly cooked foodstuffs and careful elimination preferably with an occasional dose of blue mass, and the daily administration of liquid paraffine, are advised. Autogenous vaccines or mixed stock vaccines may be used with advantage. Formerly when this disease was regarded as a purely local affection the prognosis was bad as to cure; to-day it is more hopeful.

NOTE.—The claim that endamœba buccalis is an etiological factor in Riggs' Disease does not appear to be substantially established. Endamœbas are to be found in pyorrhœal pockets. Although numerous observers state definitely that the endamœbas are the cause of periodental diseases, and that these are curable by the hypodermic and local use of emetin hydrochlorid, very many dental surgeons are not in accord with this opinion.

Syphilis of the Jaws.—Syphilitic disease of the jaws is exclusively a tertiary affection, the lower jaw being most commonly involved. The disease manifests itself by a thickening of the periosteum, the formation of gummata and caries. Diffuse or circumscribed painless swellings develop on the external surface of the lower jaw. Exostoses frequently form, and periosteal gummata lead to necrosis and absorption of bone; thus bony structures disappear and fragility results. This process is many times associated with a pyogenic infection. The diagnosis is made from the history of the case and the detection of painless periosteal thickening. When suspected, the diagnosis should be clinched by a positive Wassermann reaction.

Treatment.—Treatment resolves itself into the application of general syphilitic remedies. If secondary infection or sequestra exist, surgical measures are indicated.

Phosphorus necrosis of the lower jaw is at present a rare disease. The use of red phosphorus and the exclusion of phosphorus fumes in match factories, has practically eradicated this affection.

Tumors of the Jaws—General Characteristics.—Sarcoma is the most common tumor of the jaws, the upper and lower jaw being about equally affected. It occurs most frequently during young and middle life. Traumatism, chronic alveolar ulceration, or abscess are predisposing factors. Sarcomata are usually vigorously malignant. A tumor may be sarcomatous from the very beginning, or may later become sarcomatous. The anatomic origin of sarcoma of the upper jaw is usually from the alveolar process and the body. Occasionally these tumors may have origin in the hard palate, maxillary antrum, sphenomaxillary fossa or nasopharynx. Sarcomata of the lower jaw originate with equal frequency from the body or alveolar process. A sarcoma may originate from the surface or central parts of the maxillary bones. The surface or periosteal sarcomata have their origin in the periosteal tissues. Structurally the periosteal sarcomata may be divided into several histomorphological types; the mixed-cell variety, containing a relatively large amount of intercellular material, is the least malignant and may exist as a benign tumor. However, it must be noted that apparently benign tumors may at any time become malignant. The round or spindle-celled varieties are usually progressively malignant, but most malignant of all is the melanotic (pigmented) sarcoma. The central or myelogenous sarcomata originate from the bone marrow. Histologically they are made up of multinucleated cells imbedded in a considerable quantity of round or spindle-shaped cells, the intercellular substance being usually of a homogeneous nature. Blood-vessels are quite abundant and hemorrhage frequently takes place within the tumor substance, resulting in the formation of blood cysts which later become altered in color and consistency. Their growth is fairly rapid and they may attain considerable size, invading, destroying, and pushing neighboring tissues aside. The tumor is soft, does not produce metastases, and is to be regarded as only locally malignant. The history of trauma and chronic inflammation of the jaw as predisposing factors, is of prime importance in making a diagnosis.

Periosteal sarcoma of the lower jaw begins in the form of a small, hard, painless elevation which generally originates from the outer or inner surface of the jaw and is slowly progressive in growth. At times it may become stationary, and later increases rapidly. The growth is often painful and tender, and as it increases in size there is difficulty in

the use of the jaw; the teeth become loose, and the mucous membrane overlying the tumor may ulcerate. Metastasis, as a rule, does not occur. Regional lymphatics become enlarged if there be infection of the oral or tumor tissues. In doubtful cases removal of a part of the tumor for microscopic examination may be necessary for a correct diagnosis. The diagnosis of the central or myelogenous sarcoma may be difficult in the very beginning for the reason that these tumors originate in the deep parts of the bone and therefore their character is frequently not made out until they break through the surface.

A tumor growing into the *maxillary sinus* may reach a considerable size without symptoms; therefore X-ray sinus examination is important if patients complain of a dull pain and pressure sensation about the maxillary sinus region; this symptom may be due to pressure of a tumor from within, outward. Finally the tumor breaks through the outer shell of the involved bone, and becomes manifest. Distant metastasis, as a rule, does not take place, and regional lymphatic glands are seldom the seat of secondary deposits. Enlarged glands may result from local infection.

Treatment.—The degree of operative removal depends upon the histologic make-up of the tumor. A giant-celled sarcoma is least malignant and often a partial removal will result in a cure, whereas a round or a spindle-celled sarcoma requires early and complete removal. A thorough curettage when the tumor is seated in the medullary spaces of the inferior maxillary bone will usually result in permanent cure and the disfiguring results of a radical excision will be avoided. In every case which is not manifestly inoperable, an attempt should be made to remove all of the tumor by excision or curettage. If the tumor is of periosteal origin, is rapid in growth, whether with or without glandular enlargement, an extensive and radical excision, including a fair margin of adjoining healthy tissue, and the removal of enlarged lymphatic glands, holds out the only chance of permanent cure.

Prognosis, as a rule, is favorable if the tumor is removed early and completely; it depends also on the extent of the involvement and the histologic character of the tumor. An unfavorable prognosis is made in cases where the growth has become very extensive, involving neighboring tissues, and showing metastasis in local lymph glands.

Epulis.—The term epulis is an ancient one and only of topographical significance. An epulis is a tumor attached to the alveolar process of either the upper or lower jaw, most commonly the latter. It is a tumor of young adult life originating either from the periosteum of the alveolar

process, the connective tissue between the periosteum and the alveolar mucous membrane, the edge of the tooth or its socket. Gaps between the teeth in the bicuspid and first molar region are the places of election. Two varieties are recognized, the *simple* and the *malignant*. Histologically, a simple or benign epulis is made up of spindle-shaped cells which in some tumors may be closely packed, so as to give the growth all of the characteristics of a true sarcoma. Again, the tumor may be

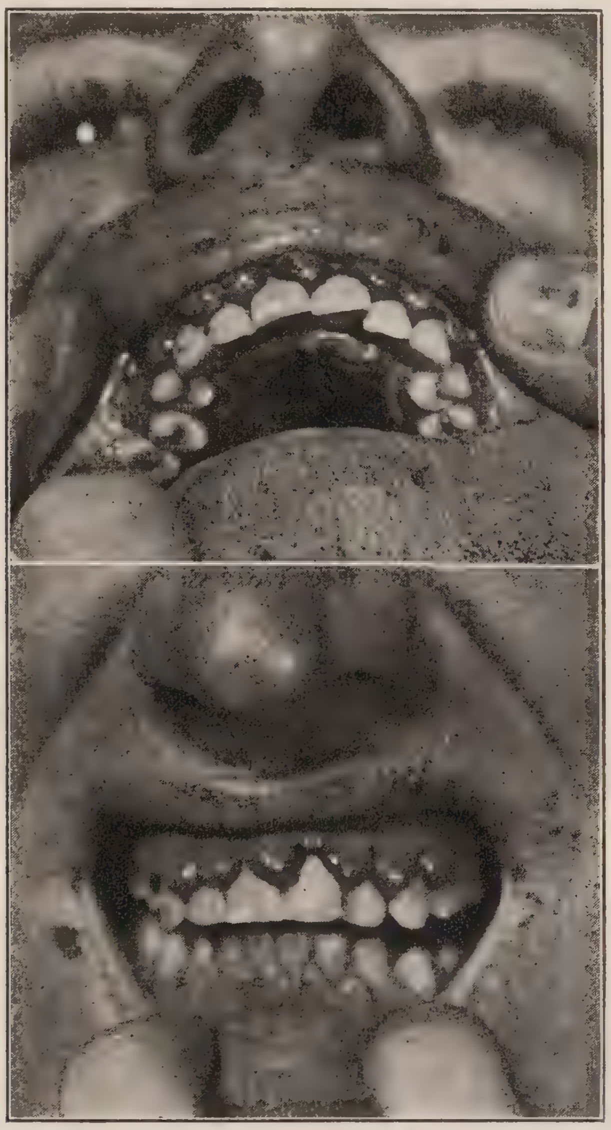

FIG. 98.—Multiple fibroma; simple epulis—probably a unique case. (Patient of Dr. W. L. Shearer.)

made up of a relatively large amount of intercellular connective tissue, thus simulating a fibroma. Clinically, a simple epulis is a benign tumor, slow in growth, requiring *one* to *three* years to reach the size of a cherry or walnut. It usually appears first between two teeth in the form of a small nodule, and spreads about the teeth and alveolar border (Fig. 98). The red fleshy mass is usually smooth, at times lobulated, elastic in consistency, and covered by normal mucous membrane.

If the tumor originates from the socket of a tooth it may be pedunculated. A simple epulis may grow to considerable size and interfere with mastication and speech. Malignant epulis is a giant-celled sarcoma originating either from the alveolar periosteum or medullary tissues of the bone. Histologically, the tumor is largely made up of multinucleated spindle and round cells, blood-vessels being more abundant than in the simple variety. The growth projects from the gum border as a soft, dark red mass covered with mucous membrane which is very apt to ulcerate. This tumor is only locally malignant and may cause considerable destruction of the tissues. Lymphatic glands are not involved but may become enlarged by infection from the ulcerated surfaces.

Diagnosis of epulis is not difficult. The growth takes the form of a circumscribed, painless swelling, of slow enlargement. An epulis originating at the root of a tooth will push the tooth outward, finally dislodging it. The process is accompanied by a dull ache or pressure pain.

Treatment.—Treatment consists of radical removal. Curettage or partial excisions often lead to recurrence. In all cases a fair margin of adjoining healthy bone should be removed with the growth. A giant-cell epulis frequently invades the body of the jaw, and in such cases excision, followed by curettage and cautery, is indicated.

Carcinoma.—Carcinoma of the jaw is a tumor of the aged, and is more common in the upper than in the lower jaw. It may be *primary* or *secondary*. *Primary* carcinomata can develop from the epithelial cells lining the mucous membrane which overlies certain parts of the maxillary bones. The epithelial lining of the maxillary sinus, and of mucous glands, as well as certain paradental indentations, may also be the seat of the primary tumor. *Secondary* carcinomata are due to an extension of a primary tumor which has originated from the parotid glands, or from the tongue or lips. Metastatic carcinoma may also occur. Chronic ulceration about the mouth and teeth, and a syphilitic soil, are predisposing factors.

Symptoms.—Pain, the first and most constant sign, may be localized, but usually there is a dull ache of one-half of the face, radiating backward, and as the tumor enlarges pressure symptoms develop. In case the upper jaw is the seat, the nostril of the affected side becomes blocked. There is swelling of the face. The tumor may invade the maxillary antrum and as it develops it destroys structures in its path; extensive ulcerations coexist. Mastication and speech become im-

paired, the breath is fetid and there is excessive salivary secretion. The ulcerating surfaces bleed readily. The submaxillary and cervical glands, as a rule, show early enlargement. Carcinoma of the jaw is one of the most rapid and malignant affections. The rapidity of the growth, the pain, lymphatic enlargement, early ulceration, and age of the patient, will readily differentiate it from a sarcoma.

Treatment.—The prognosis is very unfavorable even with early and radical operation. If the tumor has infiltrated locally and if there is lymphatic enlargement, any operative measures are useless. It is only in the early stage, while the tumor is yet localized, that a radical excision is indicated. The earlier the removal, the better the prospects of a permanent cure. Inoperable cases can be stayed to some extent by radium or X-ray.

Fibroma.—A fibroma is a dense tumor occurring more frequently in the upper than the lower jaw. It is painless, slow-growing and most common in the young. The tumor may develop from the periosteum or central parts of the bone, and, although their growth is exceedingly slow, these tumors may reach considerable size. Tumors which develop within the bone cannot be recognized until by pressure atrophy they break through the bone. As enlargement takes place, the tumor may project into the oral or accessory cavities. Growth, as a rule, is very slow, and at times is associated with pressure symptoms.

Treatment.—Operative removal is always indicated. The prognosis is favorable, but the possibility of transformation of *benign* into *sarcomatous* tumors, must be kept in mind.

Adamantoma.—During the development of a tooth the enamel cells surround the entire embryonic tooth, but as the tooth develops the enamel cells gradually disappear around that part known as the root, and persist only as a dense covering of the crown of the tooth. If, during the embryonic stage, certain masses of these enamel cells remain deeply placed (so-called cell rests or paradental epithelial nests) and subsequently begin to proliferate, a new growth called *adamantoma* results. Paradental cell rests may be some distance away from the root of a tooth, and thus the tumors be independent of the tooth. Histologically, adamantoma belongs to the cancer group. It is the least malignant form of epithelial tumor. The tumor is most frequently met with in young adults, the molar portion of the lower jaw being the most common location. The first evidence of its presence is a projection from the alveolar process. Occasionally the tumor develops a few weeks after the extraction of a tooth. Its growth is slow, but com-

monly progressive, and it may reach the size of an orange or larger. No metastasis occurs; pain, if present, is due to pressure or infection. The tumor is of irregular outline, and on section is cystic. Microscopically, mucous, fibrous, and epithelial tissues make up the bulk of the tumor.

Treatment.—As much of the growth should be removed as is consistent with the usefulness of the lower jaw. If the tumor has made considerable headway and invaded the greater part of the bone, resection of the involved jaw along with the tumor is indicated. Partial removals have resulted in permanent cures.

Odontoma.—This is a tumor resembling the structure of a tooth, and having the same degree of hardness. It usually projects from the outer surface of the alveolar process. The mass is readily shelled out after incising the overlying mucous membrane. Crown and root odontamata are hard tumors projecting either from the neck or root of the tooth.

Follicular Dental Cysts (*Follicular Odontoma*).—These tumors result when there occurs a disturbance in the normal development of a tooth, especially when there is an interference with the eruption or third stage of dentition, and the partially developed tooth, covered by a fibrous capsule, remains in the bone. As a result the encapsulated mass enlarges and finally projects from the alveolar process. The contents may be mucous, fatty, and clear or colored fluid, in which are found rudiments of tooth structure. The growth of the tumor is slow. It first manifests itself as a well-defined nodule which may project from the alveolar process, or if deeply seated, lead to an expansion of the bony walls. As the development of the cyst advances, a new growth of bone takes place in its wall; the bulging bony wall of these cystic enlargements is not a mere expansion of the original wall of the jaw bone. The cystic growth may sometimes reach a large size and cause considerable facial deformity. The X-ray should make the diagnosis positive.

Treatment.—Remove wall of cyst with curved scissors or scalpel and bone-cutting forceps.

Prognosis is good as a rule, no recurrence taking place after partial removal.

Cystoma.—Cystomata are tumors having a connective-tissue stroma, in which are embedded cystic cavities. These tumors are the result of epithelial inclusions within the substance of the jaw. During their growth the surrounding bone undergoes atrophy, and the cystic

tumor becomes surrounded by a fragile wall of thin bone, through which it breaks, and extends into the soft parts. As a rule, the nature of the tumor is first recognized at operation, which consists in *excising* and *removing* all cyst cavities.

Osteoma, chondroma, and mixed tumors rarely develop from the jaw.

Trifacial Neuralgia.—*Etiology.*—The essential cause of trifacial neuralgia is unknown. Sometimes there is a distinct hereditary history. It seems that the majority of cases are due to some form of systemic or chemical intoxication or infection. The chemical toxins are chiefly the mineral poisons, lead, arsenic, mercury, alcohol, and nicotine. Auto-intoxications due to chronic intestinal stasis or chronic constipation are also blamed. Many of the most severe types of trifacial neuralgia occur in individuals who present all the symptoms common to chronic intestinal intoxication. Among the infectious causes, malaria stands first, especially the chronic variety associated with enlarged spleen. Other infectious diseases, except syphilis, are incomparably less often the cause of neuralgia. In syphilis the neuralgic affection may be due to interstitial changes in the nerves, or to pressure on the nerve the result of periostitis or gumma formation. Syphilitic neuralgia is a late manifestation, and neuralgia in the early stage of syphilis must be ascribed to other causes. Some relation between "colds" and the cause of neuralgia surely exists. Quite frequently within a few hours after facing a cold wind, the individual is "struck" with an attack of supraorbital neuralgia. Sinus infection may be the direct cause of neuralgia. The metabolic intoxication of pregnancy may be the only etiologic factor discoverable.

Pathology.—No definite and constant pathologic changes are found in the Gasserian ganglion even in severe cases of trifacial neuralgia. It is evident that trigeminal neuralgia is not a definite disease, but merely a symptom of various processes affecting the fifth nerve anywhere in its course. Neuritis, beginning in the terminal division and tending to ascend, is the most common form of the disease. When of ganglionic origin the trouble begins as an interstitial inflammation in the Gasserian ganglion, and is most severe and progressive. A central neuritis, either in the posterior nerve root or optic thalamus, evidently exists. The central irritation causes the peripheral pain, which ceases on section of the posterior root of the Gasserian ganglion.

In neuralgic affections of the ophthalmic division, the pain is most severe in the supraorbital region, and extending up to the vertex fre-

quently involves the adjacent temporal region and the eyeball. The conjunctiva becomes congested, lachrymation is increased, and there is extreme sensitiveness to pressure over the supraorbital foramen. The skin of the involved region becomes reddened, swollen, and tender to pressure.

When the second division (supramaxillary nerve) is affected, the pain is especially located about the upper jaw, the teeth, gums, and hard palate. The skin over the lateral nasal and infraorbital regions becomes slightly swollen and tender. Quite often the patient seeks relief from the aching teeth, which are frequently extracted regardless of their healthy condition. The patient is not relieved for the reason that the entire jaw is the seat of pain. In all cases of toothache without decay, one must always suspect neuralgic conditions. In neuralgia of the third division (inframaxillary nerve), the pain is located in the tongue, floor of the mouth, lower jaw, and sometimes the skin of the lateral maxillary and auriculo-temporal region.

Symptoms, Diagnosis.—The distribution of the pain depends upon the branches of the trifacial involved. It may be limited to certain terminals of one of the three divisions. In the central form of the disease, the pain corresponds to the distribution of all three trunks.

Neuralgic pains are commonly confined to one side of the face and forehead. The pain is usually constant, with paroxysms of severe attacks, or there may be pain-free intervals between the attacks, and again in some cases, the pain is continuous without exacerbations. In the paroxysmal attacks the pain is stabbing, tearing, and of a lightening-like, sudden onset. The pains may occur at intervals of a few minutes or of hours, and last from one to five minutes.

The parts are usually sensitive to touch, and are at times reddened and swollen. During the attacks, motion of the parts increases the pain. The most sensitive point to pressure is at the exit of the nerve from its bony canal, especially is this true of the *supraorbital* and *infra-orbital* nerves. The most severe type of trifacial neuralgia is associated with a facial spasm and bears the distinctive name, "tic douloureux." The spasm of the facial muscles is secondary to the pain. Before deciding upon the diagnosis of facial neuralgia one must exclude pains due to local inflammations, rheumatism, and pain due to pathological changes in the teeth or sockets. Pain in these conditions is constant and diffuse, and not limited to the distribution of certain nerves. No differentiation is at present established between a true neuritis and a neuralgia of the trifacial nerve.

Treatment.—The treatment of trifacial neuralgia should first be directed to the cause. It is a known fact that the condition is frequently secondary to other pathologic processes which, if relieved, lead to cure of the neuralgia. In those cases in which an etiologic factor cannot be determined, one must treat the neuralgia as a primary affection of some part of the nerve tract. Every case demands a most careful examination as to the possible etiologic factor. Acute and subacute mild cases are as a rule benefited by non-surgical treatment. In chronic or severe cases the outlook from palliative treatment is not so encouraging. The first treatment should always be medicinal, mechanical, physical, or electric. The most useful remedies are Fowler's solution of arsenic, belladonna, strychnine, aconite, and large doses of phosphate of quinine. Antisyphilitic treatment is employed if there is any suspicion of syphilis (even if a Wassermann reaction is negative). Galvanism of the affected nerve tracts should supplement internal treatment. Local applications of heat or some irritating liniment will often be useful adjuncts. If the action of medicine is unavailing, recourse to injections of 95 per cent. alcohol directly into the substance of the affected nerve is indicated. If recurrence takes place, the alcohol injection may be repeated as often as becomes necessary. Attempts should always be made to inject the trunk of the affected nerve, and if this is not possible, the branches may be injected separately. An exact anatomic knowledge of the region to be injected, is a prerequisite. The amount of alcohol injected depends on the size of the nerve—from 10 to 30 minims of the commercial grain alcohol suffices. The injecting needle should enter the nerve fiber. Injections into the immediate vicinity, so that the alcohol will surround the nerve, are of some benefit; though not so effective as injections into the nerve, they may serve the purpose in case of small nerve fibers. Alcohol, when injected into a nerve, causes a degeneration of the distal fibers. Return of sensation or of the original trouble is frequently observed and is due to regeneration or formation of new axons distal to the point of the alcohol injection.

Operations upon the peripheral nerves and Gasserian ganglion can be undertaken if alcohol injections have not been successful. The painful peripheral nerve, after careful isolation, can be torn or twisted from its bony canal, a procedure highly praised by Belgian surgeons. Following the avulsion or resection, the bony canal can be blocked with lead plugs or metal screws, as advocated by Mayo. Simple section of a sensory nerve will give but a few weeks' relief, as sensory nerves

are very prone to regeneration. The greater the gap between the cut ends, the longer the delay in regeneration. The above procedure is especially indicated in affections of the superior maxillary and supraorbital nerves. If injections and resections fail, intracranial operations are indicated, especially when all three branches of the trifacial nerve are involved. Tearing away, or resection of the Gasserian ganglion is no longer practised. Section of the central root of this ganglion seems to be the operation of the future. The rationale of the operation depends upon the inability of the central root to undergo regeneration. This is explained by the fact that the trophic cell body of the sensory fibers is situated in the Gasserian ganglion, that a section of the afferent axon of these ganglionic cells leads to a degeneration of the sensory fibers, going brainward. The degeneration of the posterior root fibers will extend to the nuclei of termination in the brain. The posterior root fibers are covered by a neurilemma which disappears as the fibers enter the spinal cord or brain; therefore all the nerve fibers of the central nervous system are incapable of regeneration. Only those fibers provided with a neurilemma have the possibility of regeneration.

The operations for trifacial neuralgia are described on p. 173.

Etiology of Facial Paralysis.—The long and complicated course of the facial nerve through its bony canal in the temporal bone, and the fact that the rigid walls of the canal are in close contact with the nerve, make it easy for this nerve to be compressed by bone injuries distorting the canal, as in basal skull fractures involving the petrous portion of the temporal bone, or inflammatory processes within or external to the nerve. The chief causes leading to a peripheral paralysis are basal skull fractures, middle-ear disease, tumors of the internal ear, meningitis, syphilis, aneurisms, rheumatic conditions, and complicating acute infectious diseases. Injuries to the nerve at its point of exit from the stylomastoid foramen, as by blows, stab wounds, compression by enlarged glands, or tumors, are prominent etiologic factors. The most common cause, however, of peripheral paralysis is a neuritis due to exposure to a cold draught on the face, especially during sleep. As a result the nerve swells in its unyielding bony canal, and paralysis follows; this form of paralysis is called Bell's palsy. Central facial paralysis may be due to a lesion in the pons, crus, internal capsule or cerebral cortex. Hemorrhage, embolism, abscess and syphilitic processes are the usual causes.

Symptoms and the Determination of the Seat of the Facial Lesions.—Facial paralysis may be of gradual or sudden onset, depending on the

exciting cause. With sudden and severe compression or section of the nerve, the symptoms are immediate, and in gradual compression or ascending neuritis, the paralysis slowly develops. The patient first notices that he is unable to control labial positions, puff out his cheeks, or whistle. The face and nose draw toward the unaffected side. The eye on the diseased side cannot be completely closed nor the eyebrow elevated. The paralyzed side cannot be wrinkled. When the mouth is widely opened the labial cleft is smaller on the paralyzed side; the tongue frequently deviates toward the sound side. The buccinator being paralyzed, food and saliva accumulate about the internal buccal region. In lesions of the facial nerve, at or above the geniculate ganglion, the sense of taste is impaired and high-pitched notes are not readily recognized by the affected ear. Given a case of facial paralysis, the first question to decide is whether we have a central or peripheral lesion. In central lesions, usually caused by hemorrhage, the adjacent motor areas of the arm or of half of the body, are probably likewise involved. "When the cortical center or the upper axons are involved, the paralysis is on the opposite side, and of the upper neurone type. When the trunk of the nerve is affected, the paralysis is on the same side as the lesion and is of the lower neurone type." Electrical excitability is preserved. In peripheral lesions there soon occurs muscular wasting and complete loss of electric response. For further detail standard works on neurology must be consulted.

The prognosis of facial paralysis, due to cold, is generally favorable. Paralysis due to section without much destruction of tissue likewise offers a favorable prognosis. From three to six months is required for regeneration of the nerve. Destruction of a segment of ¼ or ½ in. of the nerve, or the presence of a foreign body in the path of the nerve, usually prevents regeneration. The prognosis in central lesions depends upon the degree of pressure or the extent of degeneration.

Treatment.—Surgical intervention is indicated in certain cases of facial paralysis, especially those which show no improvement after the first six months. In all cases of facial palsy, attempt should be made to ascertain the etiological factor. If paralysis is due to a tumor or other mechanical cause, the case is a surgical one from the start. Further progress may be prevented and a possible cure established by removing the cause.

Anastomosis of the Facial Nerve.—In facial paralysis good results have been obtained by implanting the spinal accessory or the hypoglossal nerves into the facial. If the accessory nerve is used, a good

result usually means that the facial muscles of the patient will contract when he moves his shoulder. Ballance, Körte, and Frazier therefore prefer to use the hypoglossal because the nerve centers are closer and it is easier to improve the effect by education. Both end-to-end and end-to-side anastomoses give good results. The latter method is preferable where, in case of failure, one is unwilling to risk paralysis of the healthy nerve used for grafting.

Operation.—"An incision, 10 cm. long (*i.e.* longer than that required for simple exposure of the facial nerve), is made along the anterior border of the sterno-mastoid extending up to the mastoid process. The posterior border of the parotid is exposed and displaced forward. According to Frazier, the nerve enters the gland by passing forwards on the outer surface of the styloid process and the digastric muscle 1 cm. above and the same distance internal to the tip of the mastoid process. When the lesion is situated higher up, as is the case in disease of the middle ear, and in which degenerative neuritis has been proved to exist right up to the geniculate ganglion (Spiller), the nerve must be followed to the styloid foramen and divided as close to it as possible. The hypoglossal nerve is then isolated at the point where it hooks round the commencement of the external carotid artery." (Kocher: Operative Surgery, Stiles, 231.) The distal end of the facial nerve is now either implanted in a lateral slit in the hypoglossal or the latter is cut across and its proximal segment is sutured to the distal segment of the facial nerve. The sutures ought to be of fine catgut and should, if possible, only involve the nerve sheaths. Oblique division of the nerves gives a broader surface of contact.

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SECTION VIII

OPERATIONS FOR TRIFACIAL NEURALGIA

By

JOHN FAIRBAIRN BINNIE, A. M., C. M., F. A. C. S.

INJECTIONS INTO NERVE TRUNKS IN TRIFACIAL NEURALGIA

Solutions.—(*a*) Alcohol 70–90 per cent. Quantity injected 1–2 cc. (Levy, Patrick). (*b*) Osmic acid 2 per cent. Quantity injected 7–15 minims (Murphy).

Instrument.—The Lévy-Baudouin cannula, 10 cm. long, 1½ mm. in diameter and graduated in centimeters (Fig. 99). The mandrin, when pushed home, protects the sharp point and so avoids injury to arteries.

FIG. 99.—Levy-Baudouin cannula.

Injection of Inferior Maxillary Nerve.—Introduce the cannula, mandrin withdrawn, at the middle of the upper edge of the zygoma; push it directly inward until it strikes the squamous portion of the temporal bone or the great wing of the sphenoid; guided by contact with these bones it passes inevitably over the foramen ovale at a depth of 4 cm. (1½ in.) from the outer surface of the zygoma. To avoid injury to vessels the mandrin may be pushed home when a depth of 1½ cm. is reached and withdrawn at a depth of 4 cm. A characteristic pain is experienced by the patient when the nerve is touched. Inject the chosen solution slowly. After a few minutes the patient has a feeling of stiffness, swelling and numbness in the territory of the injected nerve. There may be an exacerbation of the neuralgia for some hours. As a rule, the injections must be repeated six or eight times at intervals of three or four days.

Injection of Superior Maxillary Nerve.—Draw an imaginary line vertically downward from the external angular process of the frontal

bone across the zygoma. On this line introduce the cannula immediately beneath and in contact with the lower edge of the zygoma and pass it inward and a trifle upward until it strikes the back of the upper maxilla. Guided by the maxilla push the needle on to a depth of 4½ cm. (1¾ in.) or slightly more. Its point is now at the foramen rotundum.

NEURECTOMY FOR TRIFACIAL NEURALGIA

Neurectomy or Avulsion of the Supraorbital Nerve.—Locate the supraorbital notch or foramen. Make a horizontal incision parallel to and a little below the eyebrow. Separate the fibers of the orbicularis muscle. Expose the nerve as it emerges from the bone; isolate it for a short distance; seize the nerve trunk in the jaws of a fine hemostat; rotate the forceps so that the nerve becomes wound round its blades; reverse the direction of the rotation. By alternately rotating slowly in one direction and then in the other it is possible to extract most of the peripheral portion and much of the central trunk of the nerve. Plug the supraorbital foramen with a fragment of bone or a metal screw. Close the wound.

Neurectomy or Avulsion of the Second Division of the Fifth Nerve (*Superior Maxillary Nerve*).—(A) The infraorbital foramen lies about ½ in. below the lower margin of the orbit at the junction of its inner and middle thirds, *i.e.*, on a line drawn from the supraorbital notch to a point between the two bicuspid teeth. Expose the foramen through a cut parallel and close to the lower orbital margin after separating the fibers of the orbicularis. Extract the nerve by the same method as advised for the supraorbital. Plug the infraorbital foramen with a fragment of bone or a metal screw. This operation does *not* destroy the alveolar branches of the nerve.

(B) Braun and Lossen's Modification of Lucke's Operation. Expose the infraorbital nerve as in the preceding operation. From a point just below and behind the external angular frontal process make an incision backward and downward to near the tragus. From the same point cut downward and forward to the lower margin of the zygoma. Reflect the outlined flap downward. Divide the zygoma anteriorly and posteriorly and turn it downward after dividing the temporal fascia from its upper edge. Retract the tendon of the temporal muscle backward and expose the pterygo-maxillary fossa with its fat and veins. Push the fat backward with a blunt retractor thus

protecting the venous plexus and the internal maxillary artery. With a strabismus hook locate the posterior orbital fissure and distinguish the superior maxillary nerve as it runs inward, forward and upward. Catch the nerve in forceps or by a ligature and divide it as near the foramen rotundum as possible. Pull the peripheral end of the nerve out of its bony canal. Attend to hemostasis. Replace and suture the mobilized segment of zygoma. Close the wound.

Neurectomy of the Third Division of the Fifth Nerve.—(A) **Inferior Dental Nerve.**—Transmaxillary Neurectomy. From the angle of the lower jaw make an incision for about 1½ in. forward along the lower border of the jaw. Separate the masseter from the bone. Expose most of the outer surface of the ascending ramus. Apply a Doyen's bur to the bone midway between the anterior and posterior margins of the ramus and on the level of the free border of the teeth of the lower jaw. With a bur open the inferior dental canal (Fig. 100). Avulse the nerve. Plug the canal with amalgam, rubber tissue or some such material.

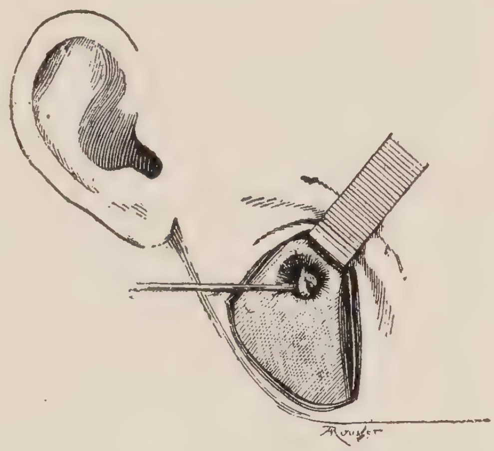

FIG. 100.—Excision inferior dental nerve. (*Lenormant.*)

B. **Neurectomy of the Lingual and Inferior Dental Nerves.**—Make an incision through the skin and subcutaneous tissue *alone*, from the middle of the zygoma backward and downward to a point slightly below the tragus. Continue the cut downward along the posterior margin of the ascending and then forward for about ¾ in. along the inferior margin of the horizontal ramus of the lower jaw. Reflect the outlined skin flap forward. Note the position of Stenson's duct and of the anterior part of the parotid. Make an incision to the bone below and parallel to Stenson's duct. This exposes the ascending ramus about ½ in. below the sigmoid notch. Denude the bone here and with a ¾-in. trephine penetrate the ramus. The upper edge of the trephine hole must not be more than ¼ in. below the notch. With forceps nip away the bone between the notch and the trephine opening. Retract the tendon of the temporal muscle forward. By blunt dissection demonstrate the external pterygoid muscle passing transversely across from the external pterygoid plate to the articular process of the lower jaw. Recognize the internal pterygoid muscle passing downward and backward from the pterygoid fossa to the inner surface of the lower jaw near its angle. Retract the external pterygoid upward and so expose the lingual and inferior dental nerves coming down from under

it and resting on the internal pterygoid. Either avulse the nerves or trace them to the foramen ovale and divide them there. Extract as much of the peripheral part of the nerves as possible. Attend to hemostasis. Close the wound.

Cushing's Operation on the Gasserian Ganglion.—From a point ½ in. behind and slightly above the external angle of the frontal bone make a curved incision to the zygoma immediately in front of the ear. The highest point of this incision is 2 in. above the zygoma. Reflect the skin downward. Subperiosteally resect the zygoma. Reflect downward a flap of temporal fascia and muscle corresponding to the skin flap. With a burr penetrate the most prominent part of the great wing of the sphenoid. Enlarge the bone opening until it is 1½ in. in diameter and extends down to and includes the ridge between the temporal and zygomatic fossæ. Lift the dura and the middle meningeal artery from the base of the skull until the attachment of the dura to the foramen is reached. Support the dura and its contents gently with a spatula. Guided by the inferior maxillary nerve, split the sheath of the ganglion to expose its upper surface. Bluntly isolate the three divisions of the trigeminus. Isolate the ganglion and its sensory root. Lift the peripheral divisions with a blunt hook and divide them. Avulse the sensory root. Temporary pressure exerted at intervals during the operation serves to control hemorrhage. Provide, if necessary, drainage by means of rubber tissue. Close the wound, anatomically, in layers. Remove the drain, if such is used, in 48 hours.

Abbe performs a similar operation but does not attack the ganglion. He divides the nerves intracranially and prevents their reunion by implanting sterile rubber tissue over the cranial openings.

SECTION IX

OPERATIONS UPON THE JAWS[1]

By

JOHN FAIRBAIRN BINNIE, A. M., C. M., F. A. C. S.

EXCISION OF THE ALVEOLAR PROCESS

A. **Excision of Tumors of the Alveolus of the Lower Jaw.**—If the disease is very limited one may, by using a large rongeur forceps, remove it, along with a safe margin of healthy bone, in one bite. If the disease is more extensive it is better to make an incision through the muco-periosteum down to the bone all round and at a safe distance from the disease. With a drill bore holes through the alveolus along the line of incision. These holes should be from ¼ to ⅜ in. apart. It is now easy to remove the diseased segment of bone with a chisel or bone-cutting forceps. Unless the jaw is weakened by some means such as that described it is difficult to cut any considerable part of it without producing a fracture.

Hemorrhage is stopped by means of packing or by the use of the actual cautery. After-treatment consists of keeping the mouth as clean as possible by means of antiseptic washes and of encouraging the patient to sit up at the earliest possible moment. Posture is a great factor in the prevention of post-operative pneumonia.

B. **Excision of Tumors of the Alveolus of the Upper Jaw.**—The methods advised in the case of the lower jaw may also be employed for the upper.

When much of the alveolus is involved and perhaps part of the palate (carcinoma, sarcoma). Schlange advocates the following operation: Provide several (three to four) gouges with blades 1 to 2 in. wide. Tampon the nostril on the diseased side. To afford access to the mouth it may be necessary to split the cheek with a curved incision running from the angle of the mouth outward and upward. "Retract the upper lip and cheek strongly upward. Open the jaws widely with a gag. Along a line as remote as possible from the tumor drive the gouges, one after the other, vertically upward through the alveolar and palatine processes

[1] See also p. 193 *et seq.*

into the antrum. In order to see what one is doing it is best to work from behind forward. The gouges, and this is important, must be left undisturbed *in situ* until the end of the resection because their withdrawal would permit severe bleeding. When the horizontal portion of the superior maxilla has been thus divided by three gouges the part to be removed is now held in place by the anterior wall of the antrum alone. The fourth gouge quickly divides the connection, when a slight leverage exerted through the chisels causes the separated bone to come away. Before the gaping wound has time to bleed it is thoroughly packed with a tampon or large sponge which has been held in readiness. The operation can be carried out in a few minutes and with almost no loss of blood."

C. **Excision of the Lower Jaw.**—Usually only one-half of the lower jaw is removed. Make an incision parallel to and a little below the lower edge of the horizontal ramus of the jaw, from the symphysis to the angle. If necessary continue the cut upward along the posterior edge of the ascending ramus to a point about one finger-breadth below the lobe of the ear. Expose, tie and divide the facial vessels. If necessary to obtain free access to the bone, make a vertical incision in the middle of the chin reaching from the horizontal incision to a point a little below the red margin of the lower lip. (If is well to avoid division of the lip itself.) Working through the incisions described, dissect the soft parts free from the outer side of the bone to be removed. If the operation is for the removal of a tumor, sacrifice the periosteum. Choose the line in which the bone must be divided anteriorly. Separate the soft parts from the inner surface of the bone along this line. Remove any teeth which may interfere with section of the bone. Divide the bone with a Gigli saw. With a lion-jawed forceps pull the bone downward and outward and separate the soft parts from the inner surface of the bone. Pull the fragment of jaw downward and divide the attachments of the temporal muscle to the coronoid process. (It may be easier to divide the coronoid process with a bone forceps and leave it *in situ*.) By a twisting movement tear the head of the bone from its articulation. Attend to hemostasis. If possible suture the mucosa of the floor of the mouth to that of the cheek. Close the external wound after providing for drainage.

After-treatment consists of endeavoring to keep the mouth as clean as possible, giving nourishment and encouraging the patient to sit up and move about at the earliest possible date. If it is not necessary to remove the ascending ramus of the jaw the operation is much.

simpler, the bone being divided behind as well as in front of the diseased segment.

When one-half of the lower jaw or any complete segment of it has been removed, much deformity results as the remainder cannot maintain its normal position. The hiatus in the bone may be filled by a strong wire, by a bar of hard rubber (vulcanite) or a segment of rib may be implanted after the wound has healed and asepsis can be assured.

D. **Excision of the Upper Jaw.**—It has been shown that excision of the superior maxilla has had a large death rate since the anæsthetic era (Kronlein, Archiv f. klin. Chir., LXIV). The commonest cause of death has been pneumonia and even the use of tracheotomy with the Trendelenburg or Hahn's cannula has not greatly improved matters. To avoid these dangers Fritz König and others perform the operation under combined infiltration and conduction anæsthesia. Most surgeons still use a general anæsthetic. To avoid hemorrhage and to gain access to the lymph glands it is wise to tie the external carotid artery. Some surgeons temporarily occlude the common carotid by means of Crile's clamp or a tape. If a general anæsthetic is used, Butlin's laryngotomy is of much value and will be described as part of the operation.

Ligation of the External Carotid Artery.—Place the patient on his back with head moderately extended and rotated toward the opposite side. Make an incision 1½ to 3 in. in length along the anterior margin of the sterno-mastoid and having its center opposite the greater horn of the hyoid bone. Divide the platysma and the deep fascia immediately in front of the sterno-mastoid throughout the length of the wound. Retract the sterno-mastoid. Find the posterior belly of the digastric muscle in the upper part of the wound, and the hypoglossal nerve a little below the digastric. Retract these structures upward. Note the tip of the greater horn of the hyoid and expose the external carotid opposite it. Demonstrate at least one of the branches of the vessel before ligating because neglect of this simple precaution has permitted the internal to be mistaken for the external carotid. Open the sheath and pass a ligature around the vessel from without inward thus avoiding the vein lying to the outer side of and frequently overlapping the vessel and thus avoiding also the superior laryngeal nerve behind the artery.

Note if there are any enlarged lymphatics. Such may be removed through the wound. Attend to hemostasis. Close the wound and apply a collodion dressing.

Preliminary Laryngotomy.—Place the patient on his back, head thrown back and neck supported by a firm pillow. Make a median incision 1½ in. long over the lower part of the thyroid, the crico-thyroid space and the cricoid. Retract the edges of the wound and ex-

FIG. 101.—Butlin's laryngotomy cannula.

pose the crico-thyroid membrane. Divide the crico-thyroid membrane transversely close to the cricoid cartilage so as to avoid injuring the vocal cords and crico-thyroid vessels. Be sure to penetrate the mucosa. Enlarge the mucosal wound by stretching it with a sinus forceps or hemostat. Introduce Butlin's cannula (Fig. 101) on its guide. Remove the guide. Fix the cannula in place by means of a tape round the neck. It is easy to continue administering the anæsthetic through the cannula. Pack the pharynx with a sponge or pad of gauze. Expose the upper jaw by Weber's or Velpeau's incision (Fig. 102). The former is preferable. If Weber's incision is chosen, reflect the flap *ABCD* outward, cutting close to the bone. Separate the periosteum covering the floor of the orbit from the bone. Gently lift the orbital contents upward with a flat retractor. With a Gigli's saw or bone forceps divide the bone at *X* and *Z* (Fig. 103) or if a more extensive resection is required at *X*, *P* and *Q*. Open the patient's mouth and with a knife make a cut through the muco-periosteum of the palate close and parallel to the middle line; continue this cut forward through the muco-periosteum covering the alveolus and to the nasal aperture. With Gigli's saw or a

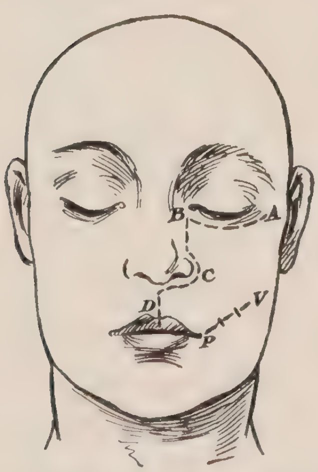

FIG. 102.—*ABCD*, Weber's incision; *PV*, Velpeau's incision.

bone forceps divide the alveolus (Y) and hard palate along the line of incision. With a knife or scissors cut the soft palate from the hard palate on the side being removed. Using lion-jaw forceps remove the

FIG. 103.—Excision of upper jaw. *X*, *Y*, *Z*, Usual lines for division of bone. *P.Q.*, section may be made here instead of at *Z*, when disease is extensive.

jaw by a twisting motion. If the internal maxillary artery is found bleeding, catch it in forceps and ligate it. Pack the wound with iodoform gauze or its equivalent. Replace the flap of soft parts and insert sutures. Remove the pharyngeal pack and when the patient is in bed remove the laryngeal cannula if such has been used.

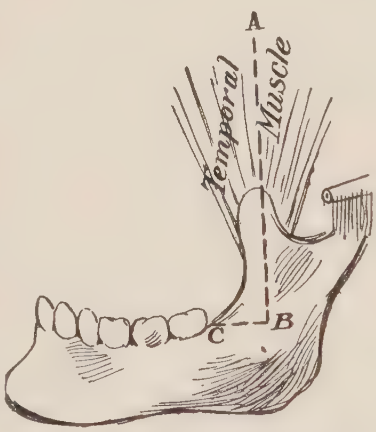

FIG. 104.—F. Konig's operation.

After-treatment.—Until he is thoroughly "out" of the anæsthetic the patient ought to be kept in the Trendelenburg position or at least with his head low and lying on the side operated upon. As soon as possible he must sit up in bed or a chair. The mouth should be frequently rinsed with mild antiseptic solutions and liquid nourishment should be given through a soft catheter passed into the œsophagus. The packing may be left *in situ* for several days and then only gradually removed. When recovery is accomplished consult a good dentist with regard to the use of an artificial palate.

If the operation has been undertaken for sarcoma the disease may extend through the infundibulum into the frontal sinus (Keen) in which

case the anterior wall of the infundibulum and the inferior wall of the sinus should be removed with fine rongeurs and the tongue-shaped process of the sarcoma wiped away.

When it has been necessary to remove the floor and the outer wall of the orbit, Fritz König advises rebuilding the orbital floor as follows: Recognize and expose the temporal muscle. Split the muscle upward and downward about 1½ finger-breadths behind its anterior margin and at the level of the coronoid process. With a chisel divide the ascending ramus of the lower jaw along the line in which the muscle was split (Fig. 104). By a transverse cut in the bone mobilize the flap consisting of temporal muscle and part of the ascending ramus. Turn this flap inward and unite its free extremity to the remnants of the frontal process.

SECTION X

DISEASES OF THE BUCCAL CAVITY

By

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STOMATITIS

This term is applied to any inflammatory condition of the buccal mucous membrane.

There are four varieties:

1. Catarrhal stomatitis.
2. Aphthous stomatitis.
3. Ulcerative stomatitis.
4. Gangrenous stomatitis or noma.

Catarrhal stomatitis is characterized by simple redness and soreness of the buccal mucous membrane; a slight degree of swelling is present accompanied by an excessive exudation of viscid mucous secretion. Any agent which acts as an irritant—such as the excessive use of alcohol or tobacco, the cutting of teeth in children, carious teeth and wounds—may give rise to this condition.

The removal of the cause quickly remedies the condition. Abstinence from irritating foods, and the use of a non-irritating mouth-wash is all that is usually required in the way of treatment.

Aphthous stomatitis is characterized by the appearance upon the mucous membrane of patches, variable in size, which are at first vividly red: later they become yellowish in color, owing to the presence of a fibrinous exudate into the superficial layers of the mucous membrane.

The patches vary in number, and show a tendency to coalesce.

The epithelium overlying them is soon shed, leaving red spots, which gradually disappear.

In the first few days after the appearance of the patches there is

some pain, salivation, fœtor of breath and fever. The disease is contagious, and is seen most frequently in the underfed, unhealthy children of the poor.

Treatment consists of plenty of fresh air, proper feeding and bland mouth-washes. If the case be a severe one, paint the patches with a 2 per cent. solution of silver nitrate, and give chlorate of potash internally.

Ulcerative Stomatitis.—The cause of this disease has not been definitely determined. The one constant etiological factor is the presence of teeth in the mouth. The gums around the teeth are first affected, and only later does extension to the rest of the mucous membrane take place.

This disease is most commonly seen in debilitated children, during either the first or second dentition. Living under bad hygienic conditions is a contributing factor. Under similar conditions it may occur among adults, when they are crowded together in ships and in armies. It may also occur in such syphilitic subjects as are susceptible to the action of mercury, or in those whose dosage of that drug has been too liberal.

The gums along the canines and the incisors are usually first affected, becoming red in color and swollen, and bleeding readily on pressure. These symptoms are accompanied by a marked feeling of malaise. The breath becomes extremely fœtid, and there is profuse salivation. Ulceration begins, and may progress along the free edge of the gums, and the teeth may become surrounded by ulcerated areas covered with a diphtheritic exudate. The teeth become loose, and fall out.

The ulceration may extend to the inner aspect of the cheek, lips and tongue. The lymphatic glands in the neck become infected and swollen. The faucial isthmus limits the disease, and the ulceration rarely appears on either the hard or the soft palate.

In severe cases osteomyelitis of the alveolar border may follow, ushered in by a high temperature and other symptoms of sepsis; portions of the bone may necrose, and pulmonary complications may end the case fatally.

Treatment.—The patient should be placed under the best hygienic conditions, and kept out of doors, if the weather permits. There are few diseases which benefit more from a life in the open.

As mastication is painful, liquid food only can be given. It should be, however, sufficient in amount, and varied in kind. It may be necessary to feed the patient, if a child, forcibly. Painting the gums

with a 2 per cent. solution of eucaine, before feeding, lessens the pain of mastication.

If the teeth become loose, they should be left alone; they may tighten when recovery takes place.

Exceptional cleanliness of the mouth is essential, and the frequent use of mild antiseptic washes is indicated; a 10 per cent. solution of hydrogen peroxide is probably the best. It is wise, however, not to continue this drug for more than three or four days.

Gangrenous Stomatitis or Noma.—This disease is characterized by a progressive and destructive form of gangrene involving the buccal cavity, and attacking by preference the cheek, less often the gums, palate and lips.

The disease is most common in children between the ages of two and twelve who have been debilitated by one of the acute specific fevers, especially measles. It appears also in syphilitic infants who have been mercurialized; in fact it may make its appearance in children after any acute illness, if they be living under unfavorable conditions. In a few cases the disease has been observed in adults, and in such it has begun as an ulcerative stomatitis.

The high mortality of this disease makes its preventive treatment in specific fevers of the utmost importance.

Symptoms.—The marked symptoms of the disease are preceded by inflammation of the oral mucous membrane. Then on the *inside of the cheek* a *vesicle* filled with bloody serum makes its appearance. This characteristic symptom may sometimes appear on the mucoperiosteum of the alveolar process or on the hard palate:

The vesicle in a few hours is replaced by a patch of gangrene, which is surrounded by a considerable amount of inflammatory induration. The cheek becomes swollen; a shiny, white patch appears upon the skin, becomes gangrenous, and perforation of the cheek takes place. The gangrene extends rapidly and is accompanied by extensive sloughing; the whole of the cheek becomes indurated, and the rest of the face œdematous and swollen; as the sloughing process extends, the odor from the necrotic tissue becomes extremely offensive. The gangrenous process may extend to the bones of the jaw. The more acute the process, the more rapidly death supervenes from septic infection and broncho-pneumonia.

The exact pathology of the disease is obscure, since the specific microörganism has not been definitely isolated. The *streptococcus pyogenes* is regarded by some as the active agent in its causation. By

others the *streptothrix of noma*, isolated by Perthes, is regarded as the cause.

This disease is less frequently encountered on the mucosa of the anus and vulva.

Treatment, to be effective, must be prompt. The whole of the gangrenous area must be freely removed. Since the knife would open up tissue spaces, as well as giving rise to some loss of blood, it is probably better to do this with the thermo-cautery.

It has been observed that early perforation of the cheek is not uncommonly followed by a favorable ending to the case. This observation shows that the removal of the gangrenous area should extend through the entire thickness of the cheek.

The local treatment should include frequent lavage of the mouth and affected area with strong solutions of peroxide of hydrogen. Every effort should be made to keep up the general health with liberal diet, good hygienic conditions and tonics.

Alveolar Abscess.—Suppuration may occur beneath the muco-periosteum of the jaws or palate. It usually arises as follows: a tooth becomes carious, its pulp is affected, and the infection travels down the root-canal and through the apical foramen into the tooth-socket; the pus formed, being in a confined space, escapes beneath the muco-periosteum and forms an alveolar abscess. If it arises in connection with the upper incisor teeth, the pus may travel beneath the muco-periosteum along the hard palate, giving rise to a prominent fluctuating swelling covered with a red, swollen and tender muco-periosteum. If the abscess occurs in connection with the second upper bicuspids and upper molars, the pus may perforate into the submucous tissue of the antrum and infect that cavity. An alveolar abscess may also have its origin in the impaction of a foreign body (such as a fish bone in the mucous membrane) or may follow a wound.

Treatment consists in opening the abscess and treating the cause, and in the employment of antiseptic mouth-washes.

Angina Ludowici.—Phlegmonous cellulitis of the floor of the mouth has been named after Ludwig of Stuttgart, who was the first to describe in detail the condition. The space between the symphysis of the jaw and the muscles of the floor of the mouth is filled up by a layer of loose connective tissue, which contains the ducts of the sublingual and submaxillary glands. The disease is an infection of this connective tissue.

The condition may arise from wounds of the mouth, carious teeth, and ulcers. A common cause is the formation of an abscess from necrosis due to the pressure of an impacted wisdom tooth.

The pathology of the disease is practically identical with that of erysipelas, the offending organisms being the streptococcus and the staphylococcus aureus.

The symptoms are of the greatest severity, and are alarmingly rapid in their development. A hard mass develops on the floor of the mouth, between the lower jaw and the hyoid bone. In a few hours the swelling rapidly extends to the neck and face. The swelling is indurated, brawny and red in color. The tissues beneath the tongue become greatly swollen and œdematous. The swelling may extend to the larynx, so that respiration is impeded by œdema of the glottis; or it may extend down from the neck on to the chest or into the anterior mediastinum. Accompanying the local condition are constitutional symptoms of marked sepsis.

Treatment.—Two main lines of treatment are indicated.

1. Recognize the primary focus from which the disease is spreading, and vigorously attack it.

If an abscess of the jaw from an impacted tooth be the *fons et origo mali*, remove the tooth, open the abscess, and drain the cavity. Ulcers and wounds, if they be the cause, should be treated on general principles properly planned.

2. By incisions provide free drainage of the cellular planes.

If the infection be mild, and above the omo-hyoid, the incision may be made into the floor from within the mouth.

If the infection be virulent, and the brawny induration extend below the jaw, then, to provide proper drainage, the incisions must be made from the outside in the following way:

A vertical incision is made from the point of the chin to the hyoid bone; lateral incisions, if necessary, are then made from the point outward by dissection. The cellular planes above the mylohyoid are opened and drained. It is expedient in most cases to open up freely the fascial compartment containing the submaxillary glands on either one or both sides, according to the extent of the induration. The advantage of this procedure is that not only is free drainage provided, but the upward pressure on the floor of the mouth is considerably relieved. The incision, when healed, lies well under the jaw. If the inflammatory process has extended lower down the neck, conveniently planned incisions must be made to provide drainage. Respiratory embarrass-

ment from œdema of the glottis must be watched for and relieved by tracheotomy.

Prompt and energetic treatment in these cases will materially lessen the possibility of a fatal issue.

SYPHILIS OF THE MOUTH

Primary.—The mucous membrane of the mouth is not an uncommon site of the extragenital chancre. Infection takes place (in order of frequency) on the lips, tongue, palate, cheek and gums.

The initial form of the disease is a small superficial ulcer with a smooth bright-red base and indurated edges. There is marked enlargement of the lymphatic glands in the draining areas in the neck. The enlargement is more extensive, and takes place much more rapidly than does involvement of the glands in a genital chancre.

Secondary Syphilitic Lesions.—*First. An erythema or diffuse redness*, involving by preference the mucous membrane of the soft palate and pharynx; its appearance is usually coincident with that of a roseolous rash. The only characteristic points about this lesion are its protracted presence, and its susceptibility to antisyphilitic treatment.

Second. Papulæ.—This form may appear anywhere on the buccal mucous membrane. The papules are usually about the size of a pea, and are distinguished by their *pale-gray color*, which is due to the maceration by saliva of the superficial hypertrophied epithelium. This destruction of epithelium may go so far that a superficial ulcer is formed. On the other hand, if the epithelium thickens and the papule develops, a picture is presented similar to the broad, raised, flat condylomata found around the anal and genital clefts.

The appearance of these papules just inside the lips is quite characteristic. In the angle is a pale-gray papule, involving both commissures, and fissured at the angle. The fissure is very sensitive and bleeds easily.

Tertiary Lesions.—Surgically, the tertiary lesions of syphilis are of more importance.

The appearance of gummata in the buccal cavity usually takes place after the fifth year. Men are more often affected than women.

Syphilis of the tongue is described elsewhere.

The gummata are frequently multiple, and may appear anywhere in the mouth.

The hard palate is more often the seat of these later lesions than

any other part of the buccal cavity. The lesion begins in the middle line, and leads to perforation of the palatine process of the superior maxilla. It is sometimes possible to remove the resulting sequestrum through the nose, leaving the mucous membrane covering the palate intact. The gumma, unless influenced by treatment, always leads to perforation and destruction of the palate.

The cheek at the lip angle and the floor of the mouth are, in this order of frequency, the next most common sites. In the first-named situation a circumscribed hard induration appears, which may extend and involve the lip, or may perforate the cheek at the angle of the mouth. This condition may be mistaken for carcinoma; but extensive syphilitic lesions in this situation are usually accompanied by signs of syphilis elsewhere.

Treatment.—The usual constitutional remedies are mainly depended upon.

TUBERCULOSIS OF THE ORAL CAVITY

As a primary affection this is extremely rare. It is more common as a secondary affection, and as such may be generated in three ways:

1. By direct extension from lupus.
2. By tuberculous sputum from the lung or larynx.
3. From the blood-stream (hæmic infection).

Lupus may extend from the lip to the mouth, or from the nose to the soft palate. The invasion of the buccal cavity is characterized by the formation of raised ulcers covered with granulation tissue, the surface of the ulcers being deeply fissured. Lupus differs from other forms of tuberculous infection of the mouth by the fact that it is much more chronic in its course, and less painful.

When the mucous membrane of the mouth has been infected with tubercle, either from the sputum or from the blood, the resulting lesion makes its appearance either as (1) vesicles, or (2) a nodule. The subsequent developments of these lesions differ.

The vesicles occur in groups, and, as each vesicle ruptures, an extremely superficial ulcer is left.

The tuberculous nodule in its early stages resembles a gumma or actinomycotic node. Later the nodule breaks down and forms a characteristic ulcer, with thin and undermined edges and necrotic base. The nodules may be solitary or multiple; when multiple they generally appear at the angle of the mouth and soft palate. The ulcers are extremely painful.

A diagnosis of tuberculous lesions of the mouth may be difficult, but will be determined by (*a*) the presence (microscopically ascertained) of tubercle bacilli in the ulcer, (*b*) a positive tuberculin injection, or (*c*) the presence of tuberculous lesions in the lungs or larynx.

Treatment.—All tuberculous manifestations in the mouth should be freely excised, provided the condition of the larynx or lungs does not contraindicate it.

If operation is not indicated, the ulcer should be treated by soothing, astringent mouth-washes.

Actinomycosis of the buccal cavity is usually associated with the same disease in the cheek, jaw and neck.

The actinomyces fungus is introduced through wounds of the mucous membrane by the sharp points of cereal grains. The fungus is usually deposited in the submucosa, and rapidly proliferates.

The cheek is not infrequently infected, and the mucous membrane soon becomes secondarily involved. The first symptom is marked induration at the site of infection. This is followed by abscess formation. The abscess ruptures and discharges either into the mouth or through the skin by sinuses, which may tunnel the cheek in many directions.

Sometimes the infection takes place in the region of a carious tooth, and a swelling very like a gumboil appears. The swelling, however, which is of slower growth, breaks down and leaves a sinus discharging a thin purulent fluid, which usually contains the fungus. The sinus may heal and break down again, and a picture closely resembling a true dental abscess is presented.

Treatment.—Early nodes should be excised. Abscesses and sinuses should be opened and curetted, and the soft tissues adjoining the abscess or sinus removed. The resulting wounds should be well swabbed out with iodine, kept open, and packed with iodoform gauze.

These operative measures may have to be repeated several times. A successful issue is the rule, provided the treatment is energetic and timely.

The local treatment may be aided by the administration of potassium iodide in large doses, or (as suggested by Bevan) by the internal administration of copper sulphate pushed to the limit of toleration.

LEUCOPLAKIA OF THE CHEEK AND PALATE

Leucoplakia frequently occurs on the mucous membrane of the cheek, and less often makes its appearance on the palate. On the cheek

the patches are more likely to become horny than on the tongue or palate, but are not so prone to ulceration. In other characteristics, including the liability to become malignant, the disease resembles that affecting the tongue.

The treatment should be excision.

TUMORS OF THE BUCCAL CAVITY

Epulis is a term applied to *any tumor* on the gums, whether innocent or malignant. When the clinical evidence does not sufficiently indicate its exact nature, a section of the growth should be submitted to a microscopic examination.

Innocent Tumors.—Angiomata, Lymphangiomata, Lipomata, Fibromata, Papillomata, Adenomata.

Malignant Tumors.—Endotheliomata, Carcinomata, Sarcomata.

Cysts.—Mucous Cysts, Dermoids.

Any of these tumors may appear in the buccal cavity.

TUMORS

An Angioma may appear, either as a simple or as a cavernous nævus, on the buccal mucous membrane. The cavernous nævus shows a marked tendency to increase in size, and the lip and cheeks may become replaced by a soft tumor with bluish knob-like projections on the mucous surface.

Treatment.—If small a nævus may be removed, the incisions going into healthy tissue outside the limits of the enlarged vessels. If very large these tumors are best left alone; repeated hemorrhage is, however, an indication for operation. Careful preliminary control of the hemorrhage is essential. If operation be out of the question, and repeated hemorrhage occurs, then the injection of absolute alcohol *deeply* into the tumor may be tried.

Lymphangiomata and lipomata are found in the tongue, but rarely make their appearance elsewhere in the buccal cavity.

Fibromata are somewhat more common, are usually pedunculated, and grow from the gums and inner side of the cheek.

Adenomata are very rarely seen in the mouth; when they do occur, the palate is the site usually chosen.

Papillomata are not uncommon. They occur frequently in connection with leucoplakia of the cheek, and present the appearance more

of a papillomatous thickening of the epithelium then of definite tumors. This condition should always be regarded with grave suspicion, as sooner or later a change to a definite epithelioma takes place. The early removal of such a papillomatous patch is always urgently necessary.

MALIGNANT TUMORS

1. **Endotheliomata or mixed tumors** may occur anywhere in the buccal cavity, but their favorite site is the soft palate. Just as in the parotid, their growth in the early stages is slow, causing slight inconvenience. Then, suddenly, their latent energy finds vent; the tumor grows actively, and presents all the features of malignancy. Wide removal is, of course, the treatment indicated.

2. **Sarcomata** occurring in the buccal cavity are usually connected with the periosteum of the jaws and hard palate, and will be described under that section.

3. **Carcinomata** may occur anywhere on the mucous membrane of the mouth, the cheek, the floor of the mouth and the hard palate being the sites most commonly affected. The majority of cases occur on the cheek, as an extension of growth from a lip carcinoma. When the growth originates in the buccal cavity itself, it is generally in connection with mechanical or dental irritation. On the cheek epithelioma is frequently associated with leucoplakia and papillomatous thickening of the epithelium; the mucous membrane opposite the last molar tooth is the most common situation.

The floor of the mouth adjoining the frænum is not an uncommon situation; occasionally the floor of the mouth is invaded by a cylindrical-celled carcinoma, which originates in the sublingual gland.

The most uncommon variety, however, is an epithelioma which appears as a hard, flat ulcer, and as it grows extends to the tongue and lower jaw.

The oral surfaces of the jaws and hard palate are affected by two clinical types of epithelioma: (1) The hard ulcerating type. (2) The soft type.

The Hard Ulcerating Type.—In this variety the induration is very evident. It surrounds an ulcer, which grows slowly and tends to extend superficially rather than invade the bone.

The soft variety is more malignant, grows more rapidly, bleeds easily, does not ulcerate so early, and tends to invade the bone and extend into the antrum.

Treatment.—The ideal operation should be adhered to, viz., wide local excision, together with that of the *glandular area* draining the part affected.

We have to consider the treatment of (*a*) carcinoma of the cheek, which frequently extends on the side of the lower jaw; (*b*) carcinoma of the floor of the mouth; (*c*) carcinoma of the palate or alveolar border of upper jaw.

Treatment of carcinoma of the cheek, which also involves the lower jaw.

1. Make incisions DCE, CB, BA, BG and CF (Fig. 105). Reflect the flaps.
2. Divide sterno-mastoid at omohyoid level. Clear out anterior, posterior and digastric triangles as far as the submaxillary gland.

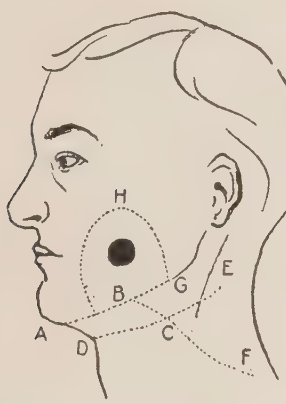

FIG. 105.

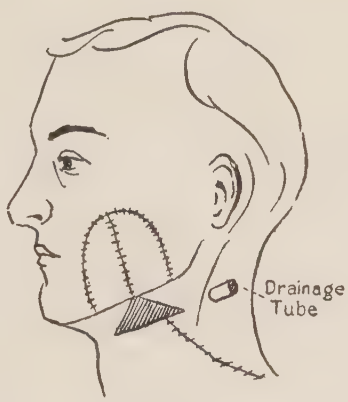

FIG. 106.

3. From before backward, dissect out the tissues containing the submental glands, as far as the submaxillary gland.
4. Divide upper end of sterno-mastoid, and from behind forward remove all tissue containing the lower glands of the parotid group, and the upper internal jugular chain. Tie the external carotid, perform laryngotomy and plug the larynx. Divide the jaw in front of and behind the growth, opening the buccal cavity.
5. Complete the incision BH; pull down the growth and infected portion of the jaw, and complete the dissection of the digastric triangle from above downward.
6. Sew up flaps as in Fig. 106, stitching the mucous membrane of the floor of the mouth to the side of the flaps, so as to fill in the areas removed from the cheek. The area left is plugged with iodoform gauze.

In very extensive cases a temporary clamping of the common carotid facilitates the operation.

In this operation the growth and its glandular draining areas are removed in continuity.

CARCINOMA OF ALVEOLAR BORDER OF UPPER JAW AND HARD PALATE

1. Clamp both common carotids as advised by Crile, perform laryngotomy and plug the larynx.

FIG. 107.

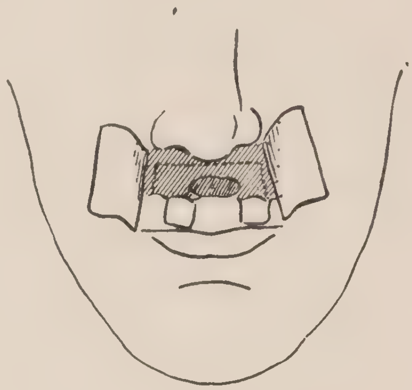

FIG. 108.

2. Make incisions as in Fig. 107. Turn back flaps, and pull up the nose.
3. Divide with a chisel alveolar border of jaw as in Fig. 108, and complete the removal of the hard palate with cutting forceps.
4. Plug the cavity with iodoform gauze.

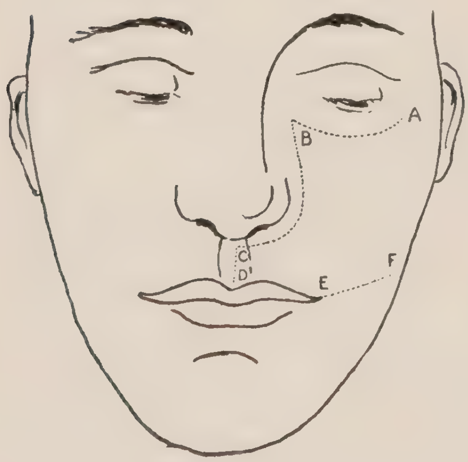

FIG. 109.

If the growth be more laterally placed, incisions ABCD and EF may be placed as in Fig. 109. Otherwise the steps of the operation are similar.

The main essentials of operations involving removal of portions of upper jaw and palate are: (1) absolute control of bleeding by use of Crile's clamps; (2) easy administration of the anæsthetic, and prevention of inspiration of blood down the trachea, by a preliminary laryngotomy.

Two or three weeks later the dissection of one or both sides of the neck, according to the nature of the case, is performed in the manner I have recommended in lingual cancer.

CARCINOMA OF FLOOR OF THE MOUTH INVOLVING LOWER JAW

1. Incision ABDEF is made, and flaps turned upward and downward (Fig. 110).

2. Dissection of this side of neck is performed as has been advised for removing glandular draining areas; it is proceeded with up to the jaw.
3. Incision BC is then made, and digastric triangle on that side dissected up as far as the jaw.
4. Clamp the common carotid on the first side dissected, tie the external carotid on the other side, and perform laryngotomy, plugging the larynx.
5. Divide the required amount of lower jaw with a Gigli's saw; widely remove the growth and complete the dissection of digastric triangle from above downward.
6. Close the buccal cavity as far as possible by stitching the tongue to the flaps.
7. Two or three weeks later make a complete dissection of the neck on the side on which the digastric triangle only had been done.

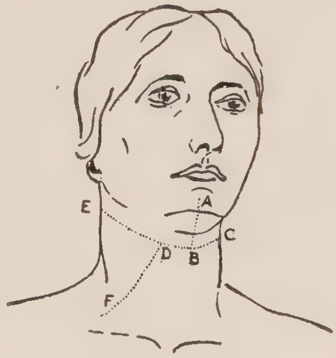

FIG. 110.

If the floor of the mouth only is involved, the operation is similar to that performed for removal of the tongue.

CYSTS OF THE MUCOUS GLANDS

Retention cysts of the mucous glands are usually situated on the inner surface of the lips and cheeks; their peculiar bluish appearance is distinctive. They are removed by shelling them out, by incision, or by destruction with the cautery.

INJURIES OF THE BUCCAL CAVITY

Wounds.—During the act of eating, slight wounds may be inflicted by pieces of bone, etc. These slight accidental injuries are usually of little importance. More severe penetrating wounds of the cheeks, soft palate and floor of the mouth are seen in children who have fallen while holding some pointed object in the mouth.

Laceration of the mucous membrane covering the gums is associated with tooth-extraction, and less frequently with fracture of the jaw. The most extensive lacerations are caused by bullets and other projectiles.

Although the enormous number of microörganisms inhabiting the oral mucous membrane cause infection only in exceptional cases, severe

and even fatal sepsis may occasionally occur, especially in wounds complicated with injury to the bones. Although the risk from tooth-extraction is usually very slight, yet a point of entrance is afforded to organisms and necrosis of the jaw may be the consequence.

Treatment.—The daily cleansing of the teeth and mouth is of very great prophylactic value in wounds of the buccal cavity. The brushing of the teeth is of the first importance.

As a rule, wounds are best left open to ensure adequate drainage.

The use of mild antiseptic mouth-washes is advisable. No strong solutions should be used; they are apt to inflame the mucous membrane, and this condition always increases the virulence of resident bacteria.

Burns and Scalds.—Burns and scalds of the buccal mucous membrane usually result from contact with steam or hot fluids.

During severe boiler explosions steam may be forced into the nose, mouth and pharynx, and may cause severe scalding of the mucous membrane.

Burns of this region not infrequently arise from children attempting to drink from the spout of a tea kettle.

The swallowing of corrosive poisons, concentrated acids and alkalis produces severe burns.

In mild cases of burns and scalds the epithelium turns a grayish-white color, and is soon cast off. In severe cases extensive swelling and œdema, followed by sloughing, may result.

Treatment.—Bland mouth-washes, and gruel as an article of diet.

SECTION XI

INJURIES AND DISEASES OF THE TONGUE

BY

SIR H. L. MAITLAND, M. CH., M. B.

Injuries to the tongue include:

1. Wounds.
2. Burns and scalds.
3. Stings of insects.

WOUNDS OF THE TONGUE

A wound of the tongue may be produced by various objects and in various ways, *e.g.*, by a fall or a blow when some foreign substance, such as a lead pencil or a pipe-stem is in the mouth, from a bayonet stab or bullet wound; but by far the most frequent wounds of the tongue are those made by the teeth. "Biting the tongue" is the consequence either of a fall or of a blow on the chin when the tongue happens to be protruded; the most serious bites occur either in epileptic or apoplectic patients.

It must be always borne in mind that a wound of the tongue may be complicated by the presence of a foreign body; and in treatment the main indication, after attending to the thorough control of hemorrhage, is to assure ourselves that no foreign substance remains inbedded in the musculature of the organ; for this is the most frequent cause of secondary hemorrhage.

The great dangers that accompany wounds of the tongue, arranged in sequence of time, are:

(*a*) Primary hemorrhage.

(*b*) Sepsis.

(*c*) Secondary hemorrhage, and occasionally

(*d*) Œdema of the glottis.

(A) **Primary Hemorrhage.**—The bleeding vessel is either near the tip or far back. If the first, its control is an easy proceeding; if the second, it is quite otherwise. A gag must be inserted and the wound temporarily plugged while arrangements are being made to stop the

bleeding permanently; or we may avail ourselves of Heath's manœuvre —passing the forefinger to the back of the tongue and hooking the whole organ forward, together with the hyoid bone, thus putting the lingual arteries on the stretch. Opening the jaws widely by means of the gag, we administer an anæsthetic and expose the wound; when the bleeding vessel is visible, we ligate it; if it is not visible, it is better to enlarge the wound slightly till the vessel comes into view and can be secured. If, however, the hemorrhage is venous, or the result of general oozing, bringing the edges of the wound together by deep sutures will probably suffice.

(B) **Sepsis.**—All stitches must be removed, incisions may be required, and the condition treated on general principles.

(C) **Secondary Hemorrhage.**—This may require preliminary laryngotomy and plugging of the pharynx. Owing to the sloughy condition of the tissues, ligation of the bleeding vessel may be a matter of extreme difficulty. It is then better to under-run the vessel with a silk ligature by means of a curved needle. If this measure be not successful, it may be necessary to tie the lingual artery beneath the chin. Having arrested the hemorrhage make diligent search for a foreign body, the most frequent cause of this complication.

(D) **Œdema of the glottis** may necessitate tracheotomy.

The after-treatment of wounds of the tongue is of importance. Oral asepsis must be promoted by the frequent use of mild antiseptic mouth-washes (carbolic acid 1 in 80, peroxide of hydrogen 1 in 4, sanitas, etc.).

A fluid diet for a time is usually necessary.

Foreign Bodies in the Tongue.—If a wound does not heal readily, or leaves an ulcer, the presence of a foreign body may be suspected. Occasionally the wound may heal over leaving a foreign substance—such as a tooth, a piece of pipe-stem, a bullet, or a needle—embedded in the tongue. If this occurs a hard, indolent and circumscribed swelling subsequently develops, which may be mistaken for a growth. The cause of such a swelling is easily overlooked if it be due to a bristle from a toothbrush or to a needle.

BURNS AND SCALDS

Burns and scalds of the tongue vary from trivial abrasions to profound destructive lesions. Slight burns arise from a lighted cigar or cigarette accidentally touching the tongue. The epithelium may be simply denuded, or ulceration may take place; and in a person past the

meridian of life the ulceration may become malignant. The severer form of burns are usually caused by mineral acids taken with suicidal intent.

Scalds of the tongue are by no means uncommon. They are more frequently met with in young children, from attempting to drink out of the spout of a kettle of boiling water.

Ice to the neck, liquid food, and bland mouth-washes are the lines of treatment indicated.

Stings from insects are so rare that the subject requires but brief attention. Wasps and bees accidentally introduced into the mouth on articles of food may injure the tongue. Considerable swelling is the marked symptom.

Inflammatory Affections of the Tongue.—As long as the mucous membrane of the tongue remains intact, the extremely numerous pathogenic germs resident in the mouth do no harm. But as soon as the soil is rendered more susceptible by injury, and the tissue-resistance is lowered, there is an increase in germ activity, which results in various inflammatory changes.

The classification suggestion by John Flynn may be taken as a poor working one.

Acute Conditions.

1. Acute superficial glossitis.
2. Suppuration of the tongue:
   (*a*) Local abscess.
   (*b*) Parenchymatous glossitis.
3. Lingual quinsy.
4. Gangrene of the tongue.

Chronic Conditions.

1. Leucoplakia (chronic superficial glossitis).
2. Ulcers:

(A) Non-specific	(1)	simple,
	(2)	traumatic,
(B) Specific	(3)	tuberculous,
	(4)	syphilitic,
	(5)	actinomycotic.

Acute Superficial Glossitis.—Acute superficial glossitis may be either *local* or *diffuse*. The *local* variety follows most slight injuries or burns, and is usually of trivial importance. Applications of borax rarely fail to effect a cure. The *diffuse* form is usually only a part of

general stomatitis, such as formerly followed the use of mercury. Occasionally, however, we meet with a condition of the tongue characterized by an herpetic eruption; it is of nervous origin, and is probably closely allied to herpes zoster. In rare cases the tongue is invaded by diphtheria; the membrane then appears at the root, and is directly continuous with that on the fauces. A membranous glossitis is also met with in children suffering from measles. A mild form of acute superficial glossitis (thrush) is due to a growth of the oïdium albicans. These three forms of the disease, however, belong to the domain of the physician.

Treatment of Acute Superficial Glossitis.—All superficial inflammatory conditions of the tongue improve on the application of bland mouth-washes, such as chlorate of potash. This drug is also of value taken internally.

Suppuration of the Tongue.—Acute suppuration occurs in the tongue, as in other tissue, under two forms: the localized, and the diffuse. It has been customary to describe these two conditions separately under the headings, abscess of the tongue and acute parenchymatous glossitis. In accordance with the teachings of bacteriology we prefer to discuss them under a common heading. Both conditions are due to pyogenic organisms; the circumscribed abscess is more especially caused by the staphylococcus pyogenes aureus and by other less virulent organisms, the so-called parenchymatous glossitis (or rather diffuse cellulitis) by the streptococcus pyogenes.

These organisms reach the tongue either directly through a wound—especially when a foreign body remains undiscovered in the lingual substance—or indirectly through the lymphatic vessels from carious teeth, or from the condition of pyorrhea alveolaris.

Acute abscess in the tongue is characterized by a tender localized swelling in the organ, of gradual onset with pain referred to the ear, and only rarely giving the physical signs of fluctuation. Diffuse cellulitis, on the other hand, spreads with great rapidity, the organ sometimes swelling to thrice its normal size in the course of a few hours. It now protrudes from the oral cavity, and is both painful and stiff. In a virulent infection the swelling may be so great as to make tracheotomy necessary to prevent asphyxia. There is always profuse salivation and great impairment of speech and deglutition; œdema of the glottis and septic pneumonia may supervene.

The treatment of either variety of suppuration of the tongue is the same as in other regions—free incision. Having previously passed a

piece of silk through the forepart of the tongue to steady it, make the cut in the dorsal surface, guiding the bistoury with the left index-finger to the tender spot. In the case of acute abscess, cut longitudinally and as deep as may be necessary to open the abscess. If the abscess is practically sublingual (that is, occupying the floor of the mouth) it should of course be opened from beneath, taking care of the ranine vessels; but it is generally better to incise the upper aspect of the tongue, since there is little fear of hemorrhage there.

In diffuse cellulitis multiple scarification is demanded; better still is a longitudinal incision on each side of the raphe, midway between it and the margin of the tongue, and cutting deeply into the muscular substance. There is marked and rapid relief from this apparently heroic treatment.

Chronic suppuration is rare, yet its possibility should be borne in mind when there exists in the substance of the tongue a small, circumscribed, smooth tumor of slow development, without any well-marked pain or tenderness. An incision clears up the doubt, and cures the disease. A very fatal but uncommon form of this disease may be due to anthrax.

Inflammation of the Lingual Tonsil (*Lingual Quinsy*).—The condition known as lingual quinsy arises from an infection of the mass of lymphoid follicle situated at the base of the tongue. In some cases it is an extension of inflammation of the faucial tonsil to the base of the tongue and the surrounding parts; in others the affection is limited to the lingual tonsil. There is tenderness at the hinder part of the tongue, together with symptoms of pressure at the tongue-base, such as dyspnœa and dysphagia.

In severe cases the treatment is incision.

Gangrene of the tongue is not often seen. It may arise from acute phagedena in smallpox, and syphilis, or from severe parenchymatous glossitis. Extension of noma from the cheek, and anthrax of the tongue, may also be responsible for it.

Treatment.—Attention to the general health; antisyphilitic treatment, if a syphilitic origin is indicated; nutrient enemata, if the patient be unable to take food; and frequent lavage of the mouth with mild antiseptics, are the proper lines of treatment.

Leucoplakia.—Leucoplakia is regarded by many authorities as essentially a chronic superficial inflammation; but it is questionable whether it should not rather be regarded as a *degeneration* indicating tissue-senescence.

The outstanding feature of this disease is keratosis; there is an overgrowth of the epithelial layers, with a disappearance of the normal papillæ.

This cornification forms smooth, white patches on the surface of the tongue. The patches may develop and extend as far back as the circumvallate papillæ. The favorite site of the disease is the anterior half of the upper surface of the tongue. The edges and under-surfaces are not so often affected. It may appear first as a red patch devoid of papillæ; this patch then becomes covered with layers of *thickened* squamous epithelium, which form a yellowish white crust.

The disease may also appear as a small bluish white patch, as if the surface of the mucous membrane had been brushed with a dilute solution of silver nitrate. This white plaque may slowly spread over the tongue, portions of it *becoming thickened and cornified.* At first the patches are smooth, but later become fissured, the fissures sometimes ulcerating. Or a benign warty growth may make its appearance. The importance of this disease lies in the fact that it is a precancerous condition. It is very chronic, and may take years to progress. But the transition of the ulcerating fissure and warty growth into an epithelioma is unfortunately anything but a rare occurrence.

Etiology.—Syphilis is undoubtedly a predisposing cause of importance.

It seldom occurs in the young, and does not often commence in persons over 60 years of age. Rarely is it seen in women. Smoking, alcohol and irritation from carious teeth are contributing causes of the disease.

The most marked examples of the disease are seen in the syphilitic whose tongue is subjected to constant irritation from alcohol and tobacco.

Smokers' patch is an early form of leucoplakia. It appears on the tongue where the pipe-stem habitually rests on it, and where the smoke strikes it. It makes its appearance in two forms:

1. As a pearly, bluish white patch, perfectly smooth; or
2. As a red, smooth patch slightly depressed below the surface, which later becomes covered with whitish, yellow epithelium. It may disappear when the source of irritation is removed, or it may go on and spread.

Symptoms.—In the early stages the disease causes but few symptoms. In later stages the patient may complain that the tongue is

hard and dry; as the patches extend and become fissured, the tongue may become painful and extremely sensitive, and eating, drinking and speaking may be interfered with. Some tongues in this condition are subject to recurrent attacks of acute inflammation, with the accompanying symptoms.

Treatment.—1. *Prophylactic.*—Since this is a precancerous condition, treatment should be begun as soon as a diagnosis is made, and all sources of irritation to the tongue should be removed. Stumps and carious teeth should be extracted, ill-fitting tooth-plates rectified, smoking and chewing prohibited, alcohol taken only in a very diluted form. Digestion should be attended to, and all articles which cause the tongue to smart should be eliminated from the diet.

2. *Local Treatment.*—Local applications do not give any permanent benefit. The patches should be removed with the knife. This form of treatment is especially indicated *when the disease is localized*, or if it be associated with *chronic ulceration.* Caustics should never be used. Mild applications, such as glycerine and borax, give some relief. Butlin recommends the application of ointments applied to the tongue after it has been dried. He uses an ointment the basis of which is cold cream, or two parts of vaseline with six of lanoline. With this basis he combines various drugs, such as cocaine, borax, morphine, etc. To individuals who sleep with the mouths open, and who suffer from a dry tongue, this treatment gives relief.

ULCERATION OF THE TONGUE

From a clinical standpoint ulcers of the tongue are:

(*a*) Evidently simple.

(*b*) Plainly malignant.

(*c*) Doubtful.

In the last case the doubt should always be solved by *excising a piece of the ulcer and submitting it to microscopic examination.*

Further, here as elsewhere there are two great classes of ulcers:

1. Chronic non-infective ulcers (*i.e.*, not due to any specific organisms).

2. Chronic infective ulcers—those that are due to the agency of a specific organism, such as the spirochæta pallida and the tubercle bacillus.

Chronic Non-infective Ulcers.—(*a*) *Simple Ulcers.*—These usually supervene on the different manifestations of chronic superficial glossitis.

It is not difficult to understand why these conditions are favorable to ulceration, since in them the epithelium covering the tongue is degenerate, unstable and poorly nourished.

Although in many tongues subject to chronic superficial glossitis there is an increase in quantity of the covering epithelial cells, still there is a deterioration in quality, and the epithelium is easily shed, leaving raw and unprotected areas that should be shielded from irritants, a condition of affairs which favors the transition of the simple into the malignant ulcer.

These ulcers are generally found close to the middle line in the anterior portion of the tongue.

Traumatic ulcer is the form which arises from the continued action of some exciting cause, *e.g.*, ill-fitting tooth-plates or rough carious teeth (dental ulcer). The situation of the ulcer is usually on the lateral borders, corresponding in situation to that of the irritating agent. It begins as an abrasion. If the source of irritation be removed at this stage, the abrasion heals; if it is not removed, it becomes a definite ulcer. If the irritation be continued, the edges become elevated and indurated, characteristics of sinister significance; the character of the ulcer has now become doubtful—it has possibly become malignant.

Herpetic ulcer may accompany an exanthem, or may be idiopathic. It makes its appearance as a vesicle which ruptures, leaving an oval, sensitive ulcer. They are usually multiple and appear in crops.

Treatment.—The essential treatment of simple ulcers consists in the early and complete removal of the cause. Remove ill-fitting plates, file or remove rough and carious teeth. Use frequently non-irritating mouth-washes, such as glycerine and borax, or saturated solution of potassium chlorate; or frequently paint the ulcer with a solution of chromic acid, 10 grains to the ounce of water.

To a painful ulcer apply a soothing application; to ulcers less sensitive apply astringents.

An important rule to follow is: *Excise a simple chronic ulcer, which does not rapidly yield to treatment.*

Chronic infective ulcers will be dealt with under the headings, Tubercle, Syphilis, and Actinomycosis of the tongue.

TUBERCULOUS DISEASE OF THE TONGUE

Although a rare disease, it may arise in various ways:

1. As lupus of the tongue, by extension from the face or by contagion from the lip.

2. As secondary to pulmonary or laryngeal tubercle, from infection carried by the sputum.

3. As hæmic infection from tubercle elsewhere.

4. As a primary lesion (this is extremely rare).

Tuberculous lesions take the following forms:

1. The nodule.
2. The ulcer.
3. The fissure.

The first sign of the disease may be the appearance of several *small nodules* on the upper surface of the tongue. These do not attain any larger size, but caseate, break down and form *an ulcer* with uneven base, with pale and flabby granulation showing through a viscid yellowish gray discharge. The edges are red, sharp-cut and indurated. Around the ulcer there may be minute yellowish elevations, which are additional tuberculous foci. The ulcer may progress and destroy the deeper parts of the organ, and may lead to the complete destruction of the tip of the tongue. The organ in this condition becomes very painful, the submaxillary glands become enlarged, and there is very great discomfort from salivation. In place of frank ulceration the nodule may break and leave a *fissure*, which is usually very deep compared with the extent of its surface. The sides of the fissure may be raised into folds, to which the name "tuberculous papilloma" has been applied.

Treatment.—When the ulcer is single and small, and there is no evidence of tuberculous disease elsewhere, excision of the diseased portion of the tongue is indicated. This radical method of treatment is especially indicated in ulcers limited to the tip of the tongue, which cause great pain on mastication and articulation. If there be coexistent disease in the lung or larynx, each case has to be decided on its merits, always remembering that cut surfaces are liable to be re-infected. All cut surfaces should be accurately stitched. When excision is impracticable, palliative measures have to be adopted. Under local anæsthesia, curette the ulcer; apply pure carbolic followed by alcohol, then dust the surface with orthoform. This palliative operation may be repeated till healthy granulation appears. Stringent mouth-washes, such as alum or tannin, are used if healing is delayed.

If the ulcer be too extensive to deal with in this way, it may be painted with a 20 per cent. solution of lactic acid every second day. Orthoform is frequently dusted on it. If this does not give relief, the surface of the ulcer should be frequently painted with a solution of eucain.

The general hygiene of the mouth should be attended to, and all sources of irritation removed. In addition the usual constitutional measures should be adopted.

SYPHILIS OF THE TONGUE

It is well recognized that syphilis in its secondary and tertiary stages may attack the tongue, but the fact that the primary lesion may make its appearance there is frequently overlooked. The disease may be conveyed from direct personal contact, or incidentally from drinking utensils, pipes, cigars, cigarettes, musical instruments, glass-blowers' pipes and dental instruments.

The various lingual lesions met with in the disease may be grouped as follows:

A. The primary chancre.

B. The secondary lesions:

(1) mucous tubercles,
(2) ulcers,
(3) fissures,
(4) bald patches,
(5) warty growths,
(6) leucomata.

C. The tertiary lesions:

(1) sclerosing glossitis,
(2) the formation of gummata.

Primary chancre of the tongue is usually seen either on the upper surface or the edge of its anterior portion. It makes its appearance in two forms:

1. As a slightly elevated erosion with a bright-red base—*smooth chancre.*

2. As a hard, *indurated ulcer* with sloping sides and foul base.

The draining lymph-glands in the neck rapidly become enlarged. This is a marked clinical feature.

A primary chancre may be mistaken for an epithelioma, *but the very early and very rapid involvement* of the cervical glands will check a hasty conclusion.

THE SECONDARY LESIONS

The lesions of secondary syphilis on the tongue are superficial, multiple and well-nigh symmetrical. The most common lesion is the mucous tubercle.

They may appear anywhere on the tongue. They are multiple, regular and rounded in shape, slightly raised and whitish in color. If irritated by the teeth they may ulcerate, these *ulcers* being superficial with clean-cut edges. Instead of definitely ulcerating, the mucous tubercle may become *fissured*. If the irritation continues, the tubercle may assume the appearance of true analcondylomata and become *warty*. This condition is seen far back on the dorsum of the tongue.

Just as the scalp in syphilitic alopecia becomes devoid of hair in patches, so may the tongue become devoid of papillæ, giving rise to the characteristic *bald patches*. Another lesion seen in secondary syphilis of the tongue is the white patch called leucoma, aptly likened to a snail's track. Such patches are, however, more often seen on the back of the palate and pharynx.

TERTIARY LESIONS

The tertiary lesions of syphilis are sclerosing glossitis and gummata.

The first stage of both these varieties is marked by small-celled infiltrations.

Sclerosing Glossitis.—In this variety the small-celled infiltration becomes converted into fibrous tissue and contracts, converting the intervening portions of the organ, as it were, into so many lobules. The lobules are painless, firm and elastic. The fissure may ulcerate, when the condition becomes a painful one.

The process may remain superficial (superficial sclerosing glossitis), which then becomes swollen and hard—a condition sometimes called syphilitic macroglossia.

Gummata.—The small-celled infiltration in this form remains localized, owing to diminution of the blood supply; the center of the gumma softens, breaks down and ulcerates.

Gummata are the most frequent lesions of lingual syphilis. They may be superficial or deep. The superficial gummata form small, multiple, knotty, irregular cords on the dorsum; when they break down the resulting ulcers are long, linear fissures, producing what is generally known as the "ploughed-up dorsum" (Fig. 111).

The deep gummata are generally single; when they soften and break down, a large irregular cavity is formed with steep, rugged borders, a sloughy, "wash-leather" base and considerable induration of the tissues around.

The deep gummata have a preference for the "avascular area" in the mid-dorsal region of the tongue.

Diagnosis.—For many years it was customary to try to solve a doubtful case by the therapeutic test; at present it is usual to rely on the result of the Wasserman reaction. *It is most undesirable to depend on either.* Seeing that a large percentage of lingual cancers supervene on a syphilitic lesion, a positive Wasserman reaction may be very misleading, since it only proves the presence of syphilis, but does not include carcinoma. The proper course to adopt in a doubtful case is *to excise a portion of the ulcer and submit it to a microscopic examination.*

FIG. 111.—Syphilis (a gumma) of the tongue.

Treatment.—A primary chancre should be treated locally with a mercurial mouth-wash.

The secondary lesions should be painted with a weak solution of silver nitrate, or a chromic acid solution (10 grains to the ounce).

Locally, the tertiary lesions are best treated with the chromic acid solution. Careful attention must be paid to the hygiene of the mouth, and all sources of irritation avoided.

Chief reliance in all syphilitic lesions must be placed upon the constitutional treatment by a course of salvarsan, combined with the internal administration of mercury and potassium iodide.

ACTINOMYCOSIS OF THE TONGUE

The tongue is occasionally the seat of this disease. As elsewhere, a nodule is the first clinical sign; the nodule breaks down and discharges through one or more sinuses, or forms an ulcer with undermined edges, and connected with pockets lined with flabby yellow-red granulation.

The underface of the tongue is usually the seat of inoculation; the disease extends to the jaw, the muscles and the neck.

Treatment.—Wide excision of the nodule should early be adopted, combined with the internal administration of large doses of potassium iodide, or copper sulphate as suggested by Bevan.

CERTAIN RARE AFFECTIONS OF THE TONGUE

Under this heading will be described:

1. Wandering rash.
2. Dyspeptic tongue.
3. Glossodynia exfoliativa.
4. Smooth tongue.
5. Black tongue.

1. **Wandering rash** occurs most frequently in children. Small circular or oval patches, each smooth and red, appear on the dorsum of the tongue. They are more commonly found toward the tip. The filiform papillæ disappear on the surface of the patch, bringing into bolder prominence their fungiform colleagues. The diseased process, subsiding at the center and spreading in the periphery, tends to the coalescence of several patches. Thus the dorsum of the tongue is mapped out into well-outlined and definite smooth areas—hence the name "geographical tongue" is sometimes applied to this condition. According to Parrot the condition is probably nervous in origin. The condition may disappear for many months and then break out again. Treatment is of no avail.

2. **Dyspeptic Tongue.**—This is a form of chronic superficial glossitis, probably due to some change in the saliva rather than to any stomach disorder. The whole of the front part of the dorsum is smooth, deprived of papillæ, "red and raw." There is well-marked increase in sensibility, hence it is easily irritated by trivial injuries. Avoidance of irritating articles of food and drink, with bland applications, is the treatment indicated.

3. **Glossodynia Exfoliativa.**—In this condition there is probably neuralgia of the lingual nerve, associated with thinning of the superficial epithelium.

4. **Smooth Tongue.**—This is not due to inflammation. The organ is deprived of all its papillæ, and the condition is analogous to partial or complete baldness. "Bald tongue" would express its nature more appropriately than "smooth tongue."

5. **Black Tongue.**—In this rare condition black spots are seen on the dorsum of the tongue. The color is due to the action of fungi and bacilli on the hair-like processes of the filiform papillæ.

SECTION XII

NEOPLASMS OF THE TONGUE

By

SIR H. L. MAITLAND, M. CH., M. B.

Tumors of the tongue may be classified as:

1. Innocent tumors.
2. Malignant tumors.
3. Cysts and tumors of the thyreoglossal tract (lingual goiter).

Innocent tumors of the tongue, with the exception of papillomata, are rare. Many varieties have been described:

1. Fibrolipomata.
2. Papillomata.
3. Angiomata.
4. Lymphangiomata.

Fibromyomata, congenital chondromata and osteomata have also been described. They are, however, pathological curiosities.

Fibrolipomata are very rare; they may be superficial, sometimes becoming pedunculated, or may be situated deeply in the organ.

Papillomata are the most common variety of innocent growth appearing in the tongue. They may appear on either side of the frænum in children during an attack of whooping cough, from irritation by the central incisors.

They are, however, commonly seen complicating the leucoplakial tongue. If subjected to irritation, they ulcerate and invariably become malignant, a change which is ushered in by induration around their base.

All papillomata, especially those associated with leucoplakia, should be removed by two elliptical incisions enclosing the base, the resulting wound being stitched accurately with silk.

Angiomata of the tongue may be either *capillary or venous*. They are generally congenital. The capillary nævi are seen as small elevated patches the size of a pea. The venous nævi are larger. Both varieties are frequently continuous with similar conditions on the face and lips. The cavernous nævi are bluish in color, and consist of groups of distended veins, which are easily compressible, filling immediately when

pressure is removed. The clinical importance of these tumors is their liability to ulceration and hemorrhage. Ulceration may be followed by serious septic complications, especially if the nævi be of the venous variety.

Treatment of Angiomata.—If the nævi are small, they may be destroyed by Paquelin's cautery at a dull red heat, or they may be excised.

For extensive venous angiomata, the following lines of treatment are available:

1. Injection of boiling water.
2. Ligation of vessels.
3. Excision of the tumor.

Injection of boiling water is liable to cause sloughing, and is, therefore, not a method to be advocated. It should be reserved for large angiomata, which bleed and slough, and are a source of danger, but are too extensive to excise. Excision is the method to be chosen. Before actually excising the tumor, care must be taken to control the hemorrhage, either by clamping the tongue itself or ligating the artery of supply.

Electrolysis, except in very small nævi, is not suitable for treatment of angioma of the tongue, because there is risk that the needle-tract will become an avenue for infection.

Arterio-venous aneurism occasionally occurs as the result of an injury. It is best treated by tying the lingual artery.

Cirsoid aneurism occupying half the tongue has been described.

Lymphangioma of the Tongue.—This tumor is not uncommon (Fig. 112). The most salient feature of the condition consists in dilated and varicose lymphatic vessels and cavernous, lymphatic spaces, and the affection is in all probability due to some interference with the return of the lymph circulation. In this connection it is well to recall that it is only the buccal segment or the segment of mandibular origin that is affected; the pharyngeal segment is practically always exempt; and it would seem as if the obstruction to the return of the lymph was located at the boundary line which separates the buccal segment from the pharyngeal.

The tumor is usually congenital, but may sometimes appear after an injury to the tongue.

On the tumor's first appearance an area (variable in size) of the tongue appears to be covered with a number of small cysts, which are due to a dilatation of the superficial lymphatics. Between the small glistening cysts are bright-red points, due to dilated capillaries. At

first the subjacent part of the tongue is soft. Later some of the vesicles become injured and rupture, and an acute glossitis may result; the inflammatory condition subsides, but small-celled infiltration is the result, which increases the size of the tongue, and hardens the base of the tumor. Accompanying these changes is an increase in size of the blood-vessels around the lymph sinus.

The inflammatory attacks recur at intervals, and the small-celled infiltration gradually enlarges and hardens the tongue till there is

Fig. 112.—Lymphangioma of one half the tongue accompanied by a cavernous nævus of the chin and neck.

difficulty in retaining it within its oral boundaries (lymphangiomatous macroglossia).

The constant pressure of the tongue may, in a growing child cause marked changes in the lower jaw. The alveolar border of the jaw is pushed outward and downward, and the teeth tend to become horizontal.

A smaller degree of macroglossia may arise from *muscular hypertrophy* (which is extremely rare) or from *inflammatory changes* due to syphilis, and excessive use of mercury. These latter causes,

however, seldom produce changes sufficiently marked to warrant the term macroglossia.

Treatment of Lymphangioma.—The treatment of the small tumors is their destruction by means of the Paquelin cautery at a dull heat; this method lessens the danger of infection and hemorrhage, and is preferable to excision.

When the whole tongue is involved, it had probably better be left alone till repeated attacks of inflammation have produced a typical macroglossia. Then the only form of treatment that offers a measure of success is the removal of wedge-shaped portions of the tongue to reduce its mass. Inflammation tends to block the lymphatics, and there is not the same risk of a spreading lymphangitis.

These measures should be adopted before deformity of the jaw has occurred.

Malignant Tumors of the Tongue.—These may be classified as:

1. Sarcoma.
2. Endothelioma.
3. Carcinoma.

Sarcoma.—This is a rare form of tumor in the tongue.

These tumors grow rapidly, and ulcerate early, presenting then the appearance of a conical growth with a central crater-like ulceration. They are very vascular, and bleed easily if injured.

It is necessary not to mistake an aberrant thyroid at the base of the tongue for a sarcoma.

Wide excision is the treatment; but here, as in sarcoma elsewhere, the ultimate prognosis is most unfavorable.

Endotheliomata are also very rare. It is probable that some of the reported cases of slow-growing sarcoma have been in reality endotheliomas They should be treated as carcinomas.

Cancer of the Tongue.—Primary cancer of the tongue is always squamous-celled (epithelioma).

An epithelioma is by far the most common form of new growth invading the tongue. It occurs much more frequently in the male than in the female. In a series of 300 cases of tongue-carcinoma on which I operated, only seven occurred in women. The explanation of this disparity in numbers is that men's mouths are more frequently the seat of precancerous conditions.

Precancerous Conditions.—In no situation are precancerous conditions so early recognizable and so well-defined as on the tongue. The importance of their early recognition and appropriate treatment can-

not be over-estimated. The following lesions frequently become carcinomatous:

1. *The wart*, especially that form associated with leucoplakia.
2. *The chronic ulcer.*
3. *The leucoplakial patch.*
4. *The chronic fissure.*

The reason for early and active surgical interference in these conditions is all the more urgent, since the stage of their transition into active malignancy is not marked by easily recognizable clinical signs. Induration about the base of the ulcer and wart, or the edges of the fissure, is of sinister significance. Chronic irritation plays an important rôle as a predisposing cause. The rough tooth, the ill-fitting dental plate, the application of strong caustics to chronic inflammatory conditions of the tongue, all do much to encourage malignancy. The importance of smoking as a predisposing cause has been exaggerated, but it becomes a very active agent in a tongue made susceptible by previous disease, especially by syphilis.

Age.—Carcinoma most commonly develops between the years of 40 and 60; and here, as elsewhere, the younger the patient the greater is the malignancy.

Situation.—The disease may attack any portion of the tongue, the sides more often than the dorsum; the under-surface and tip are generally exempt. The edge just in front of the anterior pillar of the fauces is probably the site most often chosen.

Clinical Varieties.—Cancer of the tongue in its initial stages assumes different types. This variation depends mainly on the form of the existent precancerous condition. It may begin:

1. *As an Ulcer.*—This variety usually arises from the transformation of a simple chronic ulcer on a leucoplakial patch into an epitheliomatous ulcer (Figs. 113 and 114). The edges of the ulcer become raised, nodular and hard. The base is foul, covered with offensive débris, and becomes markedly indurated. The ulcer is surrounded by white areas of thickened, proliferating epithelium. This type is probably the most common. There is early glandular involvement.

2. *As a warty mass* with hard base and edges. This variety frequently originates in a neglected papilloma, situated upon a leucoplakial patch. Less often it may be malignant from its inception, although its first appearance may be suggestive of the benign papilloma. This form is of rapid growth, and fungates early.

3. *As a Fissure.*—A fissure may exist in the tongue from antecedent

disease, especially chronic glossitis, syphilitic in origin. Malignancy is ushered in by ulceration at the bottom of the fissure, and induration of its edges.

4. *As a Hard Nodule.*—This form occurs in the substance of the tongue, beneath the mucous membrane. It may early involve the mucous membrane, and ulcerate; or more rarely it may invade the whole of the muscle of the organ, making it hard and indurated—the so-called "wooden tongue." This form resembles in its character atrophic scirrhus of the breast.

Course.—In all varieties the course is one of progressive growth, both superficially along the surface of the tongue and deeply into its

FIG. 113.—Leucoplakia of the tongue. The center has ulcerated and become epitheliomatous.

substance. The growth is accompanied by ulceration. Later extension takes place on to the floor of the mouth, sometimes invading the jaw. If the disease is situated in the posterior third of the tongue, there is early fixation of the organ, with extension of the growth on to the tonsil and soft palate.

Symptoms.—Slight pain on mastication may be the first symptom to attract the patient's attention to the disease.

Later the pain becomes severe, and is transferred from the lingual to other branches of the fifth nerve—especially to the auriculo-temporal, thus causing referred pain in the ear.

There is marked interference with the functions of the organ, with articulation, mastication and swallowing. These difficulties increase as the organ becomes fixed. Bleeding, profuse salivation, and marked fœtor of the breath add to the patient's sufferings.

The cervical lymph-glands become infected; these in time involve the skin, break down and ulcerate, and the patient usually dies within two years from exhaustion due to repeated hemorrhages or to sepsis. Metastasis to the liver or other viscera is quite exceptional.

Infection of the Lymphatic System.—1. *Of the Glands.*—Though it is difficult to locate the exact time, it may be stated that the regional lymph-glands sooner or later always become cancerous. It is certain that the interval between the appearance of the growth and the gland infection varies, even in persons of the same age. As a rule, the younger the patient the shorter is this interval.

When considering treatment, however, an important rule must be observed. In every case of lingual carcinoma it must be assumed that lymphatic infection has taken place.

2. *Of the Lymphatics.*—Cheadle has demonstrated the presence of cancer cells in the lymph spaces in the hyoglossus and geniohyoglossus muscles. On this ground it has been argued that extension from the original growth takes place by "permeation" or actual growth along the lymph spaces. It is possible that such an argument may be true. But it is certain that the most common method of extension is by embolism. Squamous-celled carcinoma elsewhere (*e.g.*, on the skin) does not infect the lymphatics themselves, but does infect the glands, and the same rule probably holds in most cases of cancer of the tongue.

Extent of Lingual Tissue to be Excised.—On the pathological evidence of lymphatic infection, and on the no less important clinical experience, we think that in lingual carcinoma *the entire half of the tongue should be removed when the growth is situated laterally, and the entire tongue when the growth is centrally placed.* When the growth has invaded the *posterior portion* of the tongue, then the *whole* of the tongue should be removed. The removal should include the lingual muscles right down to the hyoid bone.

Diagnosis.—It is only in cases of early carcinoma that the diagnosis is beset with difficulty. In the advanced cases the basal induration, the hardened raised edges, the glandular enlargement, all indicate the true nature of the disease.

It may not be easy to distinguish early carcinoma from:

1. A simple chronic ulcer.
2. A papilloma.
3. A gumma.
4. Tuberculous ulceration.

The difficulty is increased by the fact that any one of these conditions may become carcinomatous.

A simple chronic ulcer is frequently due to constant irritation; if a cause be present, such as a rough tooth or ill-fitting dental plate, that is presumptive evidence in favor of the benign character of the ulcer.

A gumma in its early stages, before ulceration has taken place, may be confused with that form of lingual cancer which begins as a nodule beneath the mucous membrane. The difficulty in making an accurate diagnosis is considerably lessened if the nodule be *multiple*, as it is not uncommon to have more than one gumma involving the tongue at the same time.

Tuberculous ulceration occurs in younger individuals. A diagnostic tuberculin injection is of assistance in a doubtful case.

A papilloma if it be sessile, may be difficult to distinguish from an early carcinoma; the difficulty is increased if ulceration has taken place, and there is some commencing induration.

In all doubtful cases, however, there is only one means of making an early and certain diagnosis, and that is by a *microscopic examination.* Under local anæsthesia a portion of the growth should be removed, and a section examined.

Treatment of Cancer of the Tongue.—The only treatment that gives any prospect of success *is the complete removal of the growth locally, together with its glandular draining area.* I wish to lay particular stress upon the necessity of the removal of the glandular draining area. I consider *it is essential, irrespective of whether the enlargement of the glands is palpable or not.*

The Risks of Operation.—A. Sepsis (including septic pneumonia).

B. Hemorrhage.

C. Shock.

A. **Sepsis.**—The mouth is always a septic cavity; and dissection in the neck, which exposes the great vessels and opens up the various fascial planes, frequently communicates with the mouth, and renders sepsis a real risk. Further, any operation in the buccal cavity, especially on the tongue, is liable to be followed by septic pneumonia, which is certainly the most common cause of a fatal ending.

The danger of sepsis may be considerably lessened if certain precautions are taken, viz.:

1. *Preliminary Disinfection of the Buccal Cavity.*—An effort should be made to get the mouth as clean as possible. The brushing of the teeth three or four times a day, and the removal of obviously carious

Fig. 114.—Cancer of the tongue.

ones, are important preliminary measures, which may be attended to a week before operation. The frequent use of a very mild antiseptic mouth-wash is also advisable.

2. *Preliminary Laryngotomy.*—There is considerable diversity of opinion as to the desirability of this step. Crile advocates the use of nasal tubes with packing of the pharynx. Kocher prefers the "hanging head" position.

I *strongly* advocate laryngotomy as a preliminary measure, for the following reasons:

(*a*) It is the most efficient method of preventing the inspiration of blood into the lungs during the operation. Since my adoption of it 12 years ago it has reduced the death-rate from septic pneumonia by 75 per cent.

(*b*) It allows the operator to work with more confidence.

(*c*) It facilitates the administration of the anæsthetic.

Marine sponges are used to plug the larynx, and the laryngotomy tube is removed the day following the operation.

3. *Adequate Drainage.*—Liberal drainage should be provided, especially in those cases where the wound in the mouth communicates with the neck dissection.

Another means of limiting the infection—and a most important one—is by judicious stitching of the soft structures. This may be combined with the use of appropriately placed iodoform pads.

B. **Hemorrhage.**—There is always a risk of this, especially in the more severe operations.

It may occur:

1. *During the operation*, and is then due to defective control.

2. *After the operation*, and is then either caused by the slipping of a ligature, or it may be true secondary hemorrhage due to sepsis.

Control of Hemorrhage during Operation.—There are several measures advocated for securing control:

1. Ligation of the lingual arteries (this, as a set operation, is rightly now seldom adopted as a means of controlling hemorrhage in excision of the tongue.

2. Ligation of one or both external carotids.

3. Temporary closure of both common carotids with Crile's clamps.

The method adopted, however, will depend on the extent of the operation.

Ligation of One or Both External Carotids.—As a dissection of the glandular draining areas of the neck is an indispensable complement of

the operation for removal of the tongue, and the common carotid and its branches are exposed in clearing the triangle, the *external carotid can then be ligated.* If the operation be a very extensive one, I prefer to adopt Crile's method of controlling the hemorrhage, viz., *temporarily clamping both common carotids.* It has been stated that this is a dangerous proceeding. It is not so. I have adopted Crile's method on over 300 occasions, and have only once seen hemiplegia following it. I regard it as a perfect, effectual and safe surgical procedure.

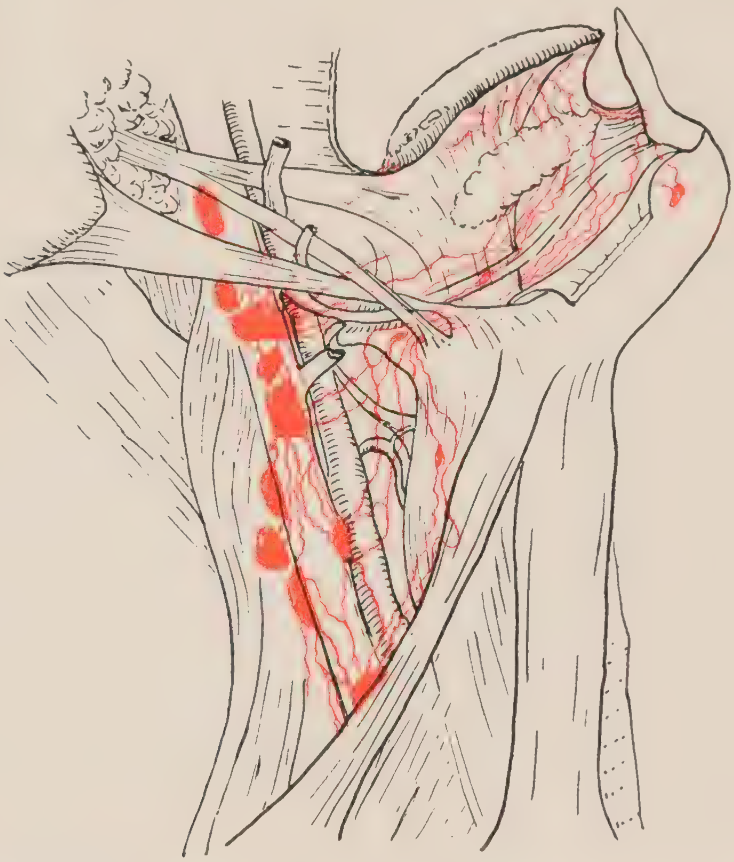

FIG. 115.—Lymphatics of the tongue. Areas likely to be involved in cancer of the tongue. (*After Leaf.*)

C. **Shock.**—Shock apart from blood-loss is not a salient feature of the operation.

An anatomical familiarity with the position of the lymphatics of the tongue, and of their collecting trunks, is absolutely essential; otherwise the necessity for and limits of a radical operation cannot be appreciated.

Lymphatics of the Tongue (Fig. 115.)—There are two groups:

1. The submucous.
2. The muscular.

Collecting trunks from these two groups unite and form four sets:

1. The anterior set.
2. The lateral set.

3. The posterior set.
4. The central set.

The anterior set arises from the point of the tongue. There are two sets on each side of the frænum: one terminates in the median suprahyoid group, the other passes between the geniohyoglossus and mylohyoid, then crosses the corner of the hyoid bone, runs along the external border of the omohyoid muscle, and empties into a gland which lies on the internal jugular vein at the point where it is crossed by the omohyoid.

It will easily be recognized, then, that in carcinoma of the tip of the tongue there must be removal of the glands as far down as the belly of the omohyoid.

The lateral set descends vertically and then runs transversely with the hyoglossal nerve over the external surface of the hyoglossus. Some of the trunks terminate in the submaxillary lymph-glands, others in the internal jugular and sterno-mastoid chains. The submaxillary glands are in very close relation to the salivary gland of the same name; hence in malignant disease it is necessary to remove the salivary gland in order to remove the lymph-glands thoroughly.

The posterior set is divided into minor sets of collectors: the *median*, which *cross frequently from one side to another*, and the *lateral*. Both sets enter the internal jugular and the sterno-mastoid chains of lymph-glands.

The central set passes between the geniohyoglossi muscles in the middle line, and runs to either or both sides of the neck. The trunks enter into the internal jugular and sterno-mastoid chains.

The extent, therefore, of the dissection of the neck ought to include a *removal of suprahyoid, submaxillary, sterno-mastoid and internal jugular groups, from the omohyoid below to the highest of the internal jugular group under the sterno-mastoid near the jugular foramen.*

Removal of the Lymphatic Glands.—Owing to the free anastomosis of

A. the central set of lymphatics,

B. all the lymphatics in the posterior portion of the tongue,

the glandular areas *on both sides* should be removed, if

(*a*) the growth is centrally placed, or

(*b*) the root of the tongue is invaded.

It sometimes happens that, even when a growth is laterally placed, the glands on the opposite side of the neck become invaded. Fortunately the occurrence is not common; but, as it does occur, it is wiser

to remove the glandular areas *on both sides*, if the lymphatic invasion is *marked* on the side of the growth.

Pathological knowledge of the method of the spread of carcinoma in the lymphatic system, fortified by clinical experience, makes us emphasize the fact that the lymph-glands, the lymphatics, the tissues which carry them and the primary growth should be removed *at the one operation.*

The objection to this procedure is that the mouth wound communicates with the neck dissection, and septic complications are more likely to arise. But the advantages of removing the lymphatic glands, the lymphatics, the tissues carrying these structures and the original growth in continuity, in my opinion, quite outweigh this objection.

When considering the treatment, the cases fall into two groups—operable and inoperable.

Having decided that a case is operable, the next question to be decided is what operation gives the best prospect of a permanent cure. Before making this decision certain facts must be emphasized.

1. Cancer of the tongue, though generally considered as spreading by embolism, may spread by permeation, and the lymphatics at the root of the tongue may contain cancer cells when the growth is at the tip. Any removal of the organ must be down to the hyoid bone.

2. It is evident that any attempt to remove individual groups of glands is bad surgery. *The tissues which carry the lymphatics and glands must be removed.*

3. The infection of the lymphatic glands with cancer cells does not follow any definite route. The gland above the omohyoid may be the first gland involved.

4. The gland behind the posterior belly of the digastric muscle, in the angle between the internal jugular and common facial veins (the jugulo-digastric gland of Leaf), is constantly involved.

5. Equally constant is the infection with cancer cells of the three or four glands lying on the insertion of the splenius capitis muscle (the sterno-mastoid chain).

6. The majority of these glands are partially or completely *under the sterno-mastoid muscle.*

7. The glands lie embedded between layers of cervical fascia.

8. The internal jugular group lies outside the sheath of the deep vessels: . . . by removing the sheath the internal jugular vein may be left, and the glands removed.

9. Thorough removal of the glandular draining areas in the neck is facilitated by removal of the sterno-mastoid muscle.

Basing myself on these anatomical and pathological facts, a personal experience of over 300 cases of lingual carcinoma operated upon, and over 1000 cases of dissection of the contents of the triangle of the neck for carcinoma of mouth-parts generally, I have come to the conclusion that any operation for lingual cancer, to give any hope of success, must be radical and thorough.

I have been accustomed, for the last 14 years, to perform one of the following operations.

Operations for Lingual Carcinoma.—If the case be an early one, and only half the tongue has to be removed, proceed as follows:

Operation A.—1. An incision *AB* is made from the mastoid process to the middle of the superior border of the thyroid cartilage (Fig. 116). The incision *BC* is made upward to the symphysis. From the middle of the incision *AB* a curved incision *DE* is made, extending downward and backward to the clavicle.

FIG. 116.

The flaps, consisting of skin and platysma, are reflected. Their bases are broad, and the blood supply good.

2. The sterno-mastoid muscle is divided at the level of the omohyoid muscle.

3. The dissection of the anterior, posterior and digastric triangles is then carried out from that level from below upward. All the fat, lymph-glands and fascia (in fact everything in the area bounded by the flaps, including the sterno-mastoid muscle) are removed, except the main muscles, vessels and nerves. The dissection stops when the submaxillary gland is reached and pulled somewhat upward.

4. Laryngotomy is performed, plugging the larynx with soft marine sponges.

5. The external carotid is tied below the lingual and facial branches.

6. The attachments of the lingual muscles to the hyoid bone are divided.

7. The dissection of the digastric triangle is proceeded with from above, and the buccal cavity is opened from the digastric triangle along the margin of the lower jaw.

8. Working partly from the mouth and partly from the neck, half

of the tongue is excised and removed in continuity with the tissues already freed by dissection in the neck.

Operation B.—Steps 1, 2, 3, 4 and 5 are the same as in Operation A.

6. The inferior maxilla is divided obliquely through in front of the masseter with a Gigli saw. The sections of the bone are pulled apart by hooks.

7. The whole of the buccal cavity is then easily accessible and in plain view, and the *whole of the tongue* down to the hyoid bone can be removed in continuity with the contents of the triangles.

8. The jaw is wired, and the wound is closed. Adequate drainage to prevent accumulation of discharges is absolutely essential, and the area in front of the epiglottis should be made to drain directly through the lower angle of the external wound. The rest of the buccal cavity is shut off from the neck by stitching together the mucous membrane of the floor of the mouth. If sufficient mucous membrane is not available, it is shut off by iodoform gauze packing.

9. Dissection of the other side of the neck is performed at another operation a few weeks later.

This operation is reserved for cases in which the whole of the tongue has to be removed.

Both these operative measures are radical and extensive, and in my opinion the best procedures for dealing with lingual carcinoma.

Reasons for Removing the Sterno-mastoid Muscle.—1. The sterno-mastoid group of lymph-glands lies partially under the sterno-mastoid muscle in the upper part of the neck. The lower glands of the group lie exclusively under that muscle, while the internal jugular group lie for their entire length under the muscle.

2. If the carotid sheath surrounding the vessels is removed at the same time as the muscle, then the glands and the fascia in which they are embedded come away in continuity.

3. It materially simplifies and shortens the operation.

4. It allows the superior glands of the internal jugular and sterno-mastoid group to be easily accessible.

The removal of one or both sterno-mastoid muscles has very little effect on the movements of the head.

If both muscles are removed, the head is carried somewhat more erect than usual. The lateral and nodding movements are not interfered with.

Wry-neck after the removal of one sterno-mastoid does not occur.

Mortality of the Two Operations.—Owing to the varying degrees of severity of the operative measures adopted, it is difficult to grade a series accurately; so I have grouped together all the tongue cases operated upon by either of these methods, and in a series of 300 cases the death rate was 17 per cent. This mortality is higher than in less radical procedures, but it is sufficiently low to render these radical measures justifiable.

Treatment of Inoperable Carcinoma.—Little can be done, except keeping the mouth as clean as possible with frequent mouth lavage; a solution of hydrogen peroxide is probably the best. Pain is relieved by morphine. It is justifiable sometimes to remove a fungating carcinoma of the tongue to relieve local symptoms. The discretion of the surgeon and the wishes of the patient must, however, decide this question.

Radium and X-rays in lingual carcinoma stimulate growth rather than lessen it.

I have not found Dawbarn's starvation treatment of much avail.

Cysts of the Tongue.—Before proceeding to the thyroglossal dermoids, it is well to recall a few facts in the developmental history of this tract. The buccal and pharyngeal segments of the tongue arise from different regions. In the furrow which lies between these two segments of the developing tongue a bud of hypoblast proliferates and forms a solid outgrowth. This, the median thyroid bud, grows downward and backward, and after a time bifurcates. The bifurcated extremity on each side redivides repeatedly, and thus is formed a network of acini, which eventually become the isthmus and the greater part of each lateral lobe of the thyroid.

The so-called thyroglossal duct is nothing more than the tract left by the descending thyroid bud; nor is there any evidence available that it was ever a functional duct, or that it ever conveyed thyroid secretion into the mouth. In no animal yet known does the duct persist. This being so, the view usually held (that thyroglossal dermoids are retention cysts of this duct) is not at all probable. It is more in accordance with observed facts to regard them as cysts developed from aberrant pieces of thyroid displaced from the median thyroid bud in its descent. As in the case of thyroid gland normally located we get one adenoma in which there is no cystic change and another in which the entire growth undergoes cystic change, so in the thyroid tumors of the tongue aberrant pieces of thyroid may develop into cysts or into tumors. Developing in the base of the tongue, thyroid tumors may be cystic, forming

the so-called blood-cysts, or may consist of vascular thyroid tissue and be extremely liable to bleed. Fatal hemorrhage has occurred from these growths.

Other cysts occurring in the tongue are:

A. Retention cysts in connection with:

1. the *small racemose* glands in the posterior part of the tongue;
2. the glands of *Blandin and Nuhn* situated on the under surface near the lip;

(they form small, transparent cysts covered with pale red mucosa).

B. Hydatid cysts.

They form rounded, tense, cystic swellings, which may appear in any portion of the organ. They are seen oftener in this country (Australia) than elsewhere.

SECTION XIII

SALIVARY GLANDS

By

SIR H. L. MAITLAND, M. Ch., M. B.

Injuries.—It is possible for any of the salivary glands to be injured; but the parotid, on account of its comparatively exposed position, is the one most frequently damaged.

Accidental wounds of the parotid gland are of importance because alarming and even fatal hemorrhage may result from injury to the external carotid artery, and facial paralysis from division of the facial nerve.

Any of the glands may be wounded during the course of surgical operations. Healing, as a rule, readily follows. If, however, septic infection occurs, healing is delayed and a salivary fistula may be established. Such a fistula is usually only temporary.

The same importance is not attached to wounds of the sublingual and submaxillary glands, because, if a permanent fistula should result, excision of either of these glands is a simple surgical procedure, involving practically no risk and but slight disfigurement to the patient.

Treatment.—No dead spaces should be left when stitching the wound. The gland substance should be brought into close apposition by catgut sutures deeply placed, and the skin edges accurately approximated. Pressure should be applied by means of a bandage, and talking and mastication limited so as to restrict the movements of the lower jaw and secretion of saliva. A temporary fistula may result if a small duct be injured.

A penetrating wound of the parotid may damage a large vessel, and severe hemorrhage result. If such an accident does happen, the wound may be enlarged transversely, and the vessel caught in artery forceps and tied, the utmost care being exercised not to injure the facial nerve.

If the terminal portion of the external carotid itself be injured, it is safer to compress it through the wound with the finger, to tie the external carotid at its origin, and to plug the wound in the parotid to prevent reflux bleeding from the upper end of the artery. The absence

of manipulations of the deeper portion of the parotid in this way avoids injury to the facial nerve.

If the facial nerve has been divided, an attempt should be made to suture the ends.

Wounds of Stenson's Duct.—Since the direction of Stenson's duct corresponds to a line from the lobule of the ear to the red border of the upper lip, an injury to it may be expected in deep vertical wounds which cross this line. Wounds in this duct are usually followed by a salivary fistula, which is extremely difficult to cure. Owing to its small caliber, complete division of the duct is the rule. If the skin wound heals up, a salivary cyst may form in the cheek. This gives rise to a swelling which increases in size each time the patient takes food. The cyst usually ruptures externally through the original wound and forms a fistula.

If the injury to the duct be recognized at the time of its occurrence, the divided ends should be sutured together with fine catgut. If the injury be in front of the masseter, the wound had better be deepened, and the gland end of the duct implanted into the mouth through an opening in the oral mucous membrane, the external wound being carefully stitched up. If the original wound penetrates the mucous membrane, then the external wound is accurately closed, and the wound into the mouth is left open, in the hope that an internal fistula will result.

Salivary Fistula.—A salivary fistula is an abnormal tract through which the saliva reaches either the surface or the mouth.

The external fistula is the only one of surgical interest, and occurs practically only in connection with the parotid or its duct.

An external fistula is an exceedingly troublesome affliction, the continual discharge of saliva being an annoyance, which is increased by the chronic eczema produced by the constant wetting of the skin.

Salivary fistula may arise:

1. In connection with the gland.
2. In connection with the duct.

Gland Fistula.—If it arises in connection with the gland itself, it will probably close in a few weeks or, at the most; months.

The only symptom present is the exudation of varying amounts of saliva from the wound.

Duct Fistula.—The fistula of Stenson's duct may follow a wound, and less frequently impacted stone, abscess, syphilitic or tuberculous ulceration, rodent ulcer and actinomycosis. A fistula of this duct causes much inconvenience and is frequently permanent, unless operative aid is successfully given.

The small sinus, usually surrounded by a bud of granulation tissue, is most frequently situated anterior to the margin of the masseter muscle.

Treatment of Salivary Fistulæ.—1. *Of Gland Fistula.*—The tendency of these fistulæ is to heal. If the cure be delayed, the application of the galvano-cautery should be tried. This minor operative measure is usually successful. If it fails, the fistulous tract had better be excised, and the gland tissue carefully stitched with deep and superficial sutures.

2. *Of Duct Fistula.*—If a fistula has not become permanent, it may be cured by repeated cauterization of the sinus, either by heat or by a pencil of silver nitrate.

If it has become permanent, it is extremely obstinate and difficult to cure, and resort must be had to one of the operative measures. These measures have been based on different principles, which vary according to the situation and severity of the fistula.

1. *By Restoring the Normal Route.*—Expose the duct, excise the scar, dilate the distal end, and close the defect with a catgut suture. Cover in the wound with a plastic skin flap.
2. *By Converting the External Fistula into an Internal One.*—
   (*a*) Von Langenbeck's operation.
   (*b*) Deguise's operation.
   (*c*) Kaufman's operation.
   (*d*) Plastic formation of new duct (Braun's operation).
3. *By removal of the gland*, thus preventing the secretion of saliva. This measure should only be undertaken as a last resort. The facial nerve should be carefully dissected out and isolated to prevent injury, and then as much of the gland as possible should be removed.

Selection of Method.—Direct union by suture should be the method chosen for all fistulæ of the buccal portion of the duct. If the result be unsuccessful, then either the operation suggested by Deguise or by Kaufman is to be recommended. If the fistula be in the masseteric portion, it is obvious that the Deguise method is not suitable, as the masseter would be included in the ligature. If the fistula be in this situation and direct suture has failed, either Kaufman's or the "plastic" operation of Braun should be tried. If the fistula is situated near the parotid, all measures usually fail. If direct suture be not a success, partial resection of the gland is the only method that will relieve the distressful symptoms.

If a permanent external salivary fistula should occur in connection

with Wharton's duct, all inconvenience can be avoided by removal of the submaxillary gland.

INFECTIVE CONDITIONS

Inflammation of the Salivary Gland (*Sialo-adenitis*).—Some doubt still surrounds the etiology of inflammation of the salivary gland. Recent investigations, however, make it seem probable that all non-specific inflammations have their origin in the mouth, and ascending the excretory duct infect both it and the corresponding gland.

With acute primary sialo-adenitis (parotitis or mumps) we are not directly concerned, as it belongs to the domain of the physician.

Acute Secondary Sialo-adenitis.—The mouth is the habitat of multitudes of microörganisms. The fact that they are usually inert is attributed to the action of the saliva. Any cause—such as pyrexia—which *inhibits the salivary flow* tends, therefore, toward increased activity of the microörganisms in the mouth, and increases the danger of an ascending parotitis.

The impaction of a calculus in the excretory duct, abnormal conditions of the mouth (such as stomatitis, especially the form due to mercury) and sepsis are not uncommon causes of the disease. It may also accompany any of the specific infectious fevers, especially typhus and typhoid.

Post-operative Parotitis.—This uncommon variety is seen sometimes following operations, usually abdominal. There are several possible contributing factors: the temperature in septic cases, the operation itself, or the cessation of mouth-feeding may all predispose the mouth to dryness from diminished salivary secretion—a fact which, as I have pointed out, greatly increases the activity of the buccal bacteria.

This form of parotitis appears generally between the fifth and the eleventh day after the operation, and is characterized by considerable swelling and intense pain. The movements of the jaw early become restricted and painful. There is marked difficulty in swallowing and opening the mouth.

It may end in resolution about the fourth day or (which is more common) may go on to suppuration. When this occurs, the severity of the symptoms increases; the whole parotid becomes tense and greatly swollen, the skin red, œdematous and adherent, and the entire face swollen.

If the presence of suppuration be overlooked, disastrous results may follow. Pus may burrow into the temporo-maxillary joint, or into the

external auditory meatus. It may work upward toward the base of the skull, or form a retropharyngeal abscess, or find its way downward through the tissues of the neck. Large vessels in the gland may become eroded, leading to severe hemorrhage. The facial nerve may be destroyed, with consequent permanent facial palsy. Salivary fistulæ may form. Septic thrombosis of the internal jugular vein may ensue, and death from sepsis result.

The submaxillary and sublingual glands are rarely subject to inflammation, except as the result of an impacted stone.

Treatment.—When inflammation of the salivary glands occurs, the frequent application of heat in the form of fomentations gives relief. Remove the cause of the inflammation, and carefully attend to the hygiene of the mouth. When suppuration takes place, the salivary gland involved should be incised, and the pus evacuated. If it occurs in the parotid, a small horizontal incision should be made behind the angle of the jaw, the gland capsule opened, and a communicating channel made, by means of a sinus forceps, between the suppurating focus and the incision. This should be sufficiently large to permit of adequate drainage. If the submaxillary gland be at fault, the incision should be made beneath the jaw, and placed so as to avoid the facial artery.

Chronic Inflammation (*Chronic Sialo-adenitis*).—This seldom occurs in the parotid, but is not uncommon in the submaxillary glands. It is generally associated with impacted stone. The best treatment is to remove the gland.

Inflammation of the Excretory Ducts (*Sialodochitis*).—This condition is generally associated with inflammation of the corresponding gland, and has the same etiology as acute sialo-adenitis; but there are forms which may be limited to the duct itself. It most commonly affects Stenson's duct, and may lead to a thickening of the walls of the duct, and a narrowing of its lumen with periodic blockage from plugs of mucus. The symptoms much resemble those produced by salivary calculi. The only treatment of avail is to slit up the narrowed duct from its orifice, so as to provide a free opening into the mouth.

Salivary Calculi.—These are more often found in the excretory ducts than in the glands themselves. The situation of Wharton's duct, its length and width and the position of its orifice, probably accounts for the fact that it is the site most often affected. The next most common situation is the submaxillary gland itself. Calculi usually appear singly if situated in the duct, but are frequently multiple if in the gland.

They are more often found in men than in women, and generally occur during middle age.

The calculi vary in size, but usually do not exceed the size of a pea. The color is grayish white (sometimes darker) and the surface rough. They are hard in consistence. If formed in the duct, the shape is elongated or cylindrical; if in the gland, it is irregular.

A salivary stone consists of inorganic lime salts (chiefly carbonate and phosphate of lime) in an organic framework consisting chiefly of mouth bacteria. The presence of these bacteria is not accidental, as their action on the saliva is responsible for the formation of the concretion. The origin of the calculi is thus very similar to that of the tartar of the teeth. A foreign body may play some rôle in their formation—a fishbone, a fruit seed, or a small piece of tartar occasionally forms the nucleus of the concretion. Calculi may give rise to considerable inflammation in the duct and gland, which in the case of the submaxillary gland may go on to the formation of an abscess. If an abscess develops and ruptures into the mouth, the resulting sinus may simulate an epithelioma.

Instead of a localized abscess a progressive inflammation may ensue after the stone has caused ulceration of the duct. The inflammation not infrequently appears in the floor of the mouth, and may extend to the neck.

In the majority of cases a chronic interstitial inflammation of the gland is set up and it becomes hard, firm and adherent to the surrounding structures, simulating a malignant tumor.

Symptoms.—Symptoms may not make their appearance for some years, until the stone partially blocks the duct or inflammation in the duct or gland is set up.

The most characteristic symptom is the periodic appearance of a salivary tumor, accompanied by pain. These symptoms are increased at the sight of food or during a meal. This pain has aptly been termed "salivary colic," and is due to the increased outflow of the saliva being obstructed by a calculus impacted in the duct. If the calculus does not completely block the duct, the swelling disappears between meals. If, however, the duct be completely obstructed, a retention cyst is formed, which soon becomes infected and suppurates. Another marked symptom is *pyorrhœa salivalis.* If the gland be squeezed, pus is seen to issue from the gaping orifice of the duct.

The diagnosis can usually be made by bimanual palpation, by passing a probe up the duct, or by introducing a needle into the suspected site. Calculi may also be detected by means of the Röntgen rays.

Treatment.—When the calculus is in Stenson's duct it is generally lodged near the orifice and, under local anæsthesia, can easily be removed by slitting up the canaliculus and expressing the stone. A similar procedure can be adopted if the calculus is near the orifice of Wharton's duct. If, however, the stone is more deeply placed, a general anæsthetic had better be given, the stone fixed by pressing it against the ramus of the jaw, and then cut down upon. No attempt should be made to stitch up the duct. The only after-treatment required is the frequent use of an antiseptic mouth-wash.

If the stones are situated in the sublingual or submaxillary glands, or if these glands have become infected and chronically inflamed, then the entire gland had better be extirpated.

Actinomycosis of the salivary glands is not common, and is due to infection from foci in the neighborhood.

Tuberculosis of the salivary glands is a very rare affection. It is generally primary. The diagnosis is extremely difficult. This disease has been mistaken for a gumma, a sarcoma and a "mixed tumor." If a cold abscess forms, it may be mistaken for a dermoid or a salivary cyst.

Treatment.—The complete removal of the submaxillary and the partial removal of the parotid gives a very favorable *prognosis.*

Syphilis of the salivary glands is rare, but is more frequent than tuberculosis. It appears in two forms:

1. An interstitial fibrous variety.
2. A gummatous formation.

The latter is more common.

Symmetrical Disease of the Lachrymal and Salivary Glands.—This condition was first described by Mikulicz, and has been given his name. It begins in early adult life; the salivary glands slowly enlarge, remain confined to their capsules and form firm movable tumors. The disease may be accompanied by swelling of the lymphatic glands and spleen.

The etiology is obscure.

Arsenic and iodide of potassium have been recommended as therapeutic agents.

Tumors of the Salivary Glands.—Tumors of the salivary glands are of very great interest; an important group, the "mixed tumors," has long been a pathological puzzle. The tumors of the three salivary glands are pathologically alike and may be classified as:

1. Connective-tissue tumors.

2. Epithelial tumors.

3. (Of both epithelial and connective-tissue origin.) The so-called "mixed tumors."

Connective-tissue Tumors.—Angioma, lymphangioma, fibroma, myxoma, lipoma, chondroma, sarcoma.

All these tumors are, comparatively speaking, uncommon and do not present any peculiar features; many of them should probably be classified as "mixed."

If the tumor be diagnosed as sarcoma, especially melanosarcoma, the whole gland should be excised.

Epithelial Tumors.—Adenoma, carcinoma.

Adenomata are comparatively rare.

Carcinomata, next to the "mixed tumor," are the most common of

FIG. 117.—Scirrhus of the parotid showing contraction of the tissues surrounding the tumor.

tumors. The parotid is more often affected than other salivary glands. They occur in two forms: (*a*) the adenocarcinoma; (*b*) the scirrhus.

In *adenocarcinoma* the tumor is of soft consistence. The growth is rapid. The skin presents at first a tense glistening appearance, but soon becomes involved and ulcerates.

Scirrhus of the parotid resembles the mammary form. The outstanding feature is contraction of the tissues surrounding the tumor. (Fig. 117). Occasionally the skin overlying the growth becomes

markedly involved, and converted into a thick leathery covering, comparable to cancer *en cuirasse* of the breast.

The marked cicatricial contraction in this form of carcinoma accounts for the early involvement of the facial nerve.

Symptoms.—In both forms pain is usually present; as the disease advances it becomes severe, hearing is interfered with, and there is difficulty in swallowing and speaking, and in all movements of the mandible.

The adenocarcinoma is very malignant, and runs a fairly rapid course. The scirrhus is not so malignant and is of slow growth.

The *early* diagnosis of carcinoma of the salivary glands presents many difficulties.

To differentiate between a chronic inflammatory swelling and a carcinoma, especially of the submaxillary gland, is not always easy. Facial paralysis is a symptom of the utmost importance in diagnosing carcinoma of the parotid, but unfortunately it is not an early symptom.

Tubercle and syphilis also have to be considered in making a diagnosis.

The rare cases of adenocarcinoma of the floor of the mouth originate in the sublingual gland.

The treatment is the total extirpation of the glands at fault, together with their glandular draining areas.

Extirpation of the submaxillary gland is not difficult. It entails a dissection of the submaxillary triangle. The steps are:

1. Incision through the skin and platysma, as in dissection of submaxillary triangle in the operation for removal of the cervical glands.

2. Raising the flap, and division of facial vein and artery between double ligatures.

3. Lifting the gland from its fascial compartment, and tying its excretory duct.

4. Separating it from its mesial and upper attachments along the jaw, clamping and tying the facial artery and vein as they pass over the lower jaw.

If the gland is removed for malignant disease, its removal should be accompanied by a dissection of the glandular draining area of that side of the neck, as I have recommended in lingual carcinoma.

Extirpation of Sublingual Gland.—Carcinoma of this gland is not usually recognized till the floor of the mouth is extensively involved; an operation similar to that for removal of the floor of the mouth is then necessary.

Extirpation of the parotid for carcinoma is a difficult operation. As it is necessary to remove the capsule as well as the gland, I am of opinion that to do it in a satisfactory manner the ramus of the jaw must be removed; otherwise it is quite impossible to remove the gland thoroughly from the retromandibular fossa.

Another important point is to obtain absolute control of the hemorrhage, an end best achieved by tying the external carotid, or by temporarily clamping the common carotid. The facial nerve, of course, must be sacrificed.

Steps of Operation.—*Step* 1.—Skin incisions as in Fig. 118. Raising the flaps.

Fig. 118.

Step 2.—Begin dissection from below, doubly ligature the external carotid near its origin, and divide it. The distal portion of the vessel is removed with the gland. Isolate the internal jugular vein, and remove the lymph-glands of the internal jugular chain.

Step 3.—Divide the ramus of the jaw, and disarticulate it at its upper extremity. Then from above downward and from in front backward remove the whole of the parotid together with the ramus of the jaw.

Step 4.—Tie off the vessels and complete the toilet, providing drainage. In extensive cases it may be advisable to perform laryngotomy and plug the larynx. If the general condition of the patient be good, a complete dissection of the glandular areas may be performed at the same time. If not, it is done 2 or 3 weeks later.

Mixed Tumors.—The most common growth of the salivary glands is the "mixed tumor." As a rule these tumors are circumscribed and well-defined, and sometimes attain a considerable size.

They form nodular elastic swellings of uneven consistency, which either grow slowly or remain quiescent for some years, and then suddenly take on a vigorous and active growth, burrowing deeply into the gland, invading the surrounding structures and destroying life. The tumors are usually, but not always, encapsuled. The capsule to a great extent disappears when they take on a sudden and rapid increase in growth. They are more common in the parotid than in the submaxillary, and are rare in the sublingual gland.

They may grow from any portion of the parotid, the lower and an-

terior segment of the gland being the site usually selected. The extension of growth is then downward into the neck (Fig. 119).

If they arise in the center of the gland, they may obliterate the auditory meatus, or may fill the submaxillary fossa and extend toward the pharynx. If the submaxillary be the gland invaded, the growth usually starts from the superficial surface, and projects from beneath the jaw rather than toward the mouth.

These tumors contain a variety of tissues, such as fat, cartilage,

FIG. 119.—Mixed tumor of the parotid which grew slowly for 11 years.

myxomatous and lymphoid tissue, while the parenchyma cells are those peculiarly flattened ones called endothelium. Hence the "mixed tumor" is an *endothelioma*.

Treatment.—It is a well-recognized fact that if, when removing these tumors, the capsule is opened and left there is danger of a rapid and more active recurrence. It is, therefore, necessary to remove the growth *plus its capsule.*

A suitably placed incision should be made; for small tumors an incision parallel to the branches of the facial nerve is generally adequate. The capsule of the tumor is exposed; then, working outside the capsule, chiefly by blunt dissection, the tumor *plus* its capsule is separated from its connections and removed.

If the tumor is more extensive, and has taken on active malignant

growth, breaking through the capsule, the whole of the gland should be widely removed. An endeavor to save the facial nerve will generally end in the performance of an incomplete operation, with rapid recurrence of the disease.

CYSTS OF THE SALIVARY DUCTS

Ranula.—The term is usually applied to any cyst in the floor of the mouth; but it is better to restrict the term to cysts arising in connection with the ducts of the salivary glands. A ranula associated with Stenson's duct is rare, but one connected with either the lingual or the submaxillary gland is common. The cysts are rounded, translucent, and of a grayish red color, occupying the furrow between the gums and the tongue; if only moderate in size they project into the floor of the mouth, if large they become prominent beneath the lower jaw in the submaxillary triangle. The cysts are monolocular, and are filled with a viscid fluid resembling egg albumen.

The etiology of ranulæ is not always evident. They may be congenital in origin, or may be due to blockage of the duct by a calculus or cicatricial contraction.

Treatment.—The only method which gives any permanent result is extirpation of the ranula. If the cyst be small, the mucous membrane is divided under local anæsthesia, and the cyst is removed by blunt dissection. If the ranula is large and projects beneath the jaw, its removal had better be done from beneath the chin.

Small ranulæ may sometimes be cured by excising the anterior wall, painting the cavity of the cyst with iodine, and keeping the cavity plugged with gauze.

CYSTS OF THE SALIVARY GLANDS

Retention cysts may form in the glands themselves. If there be some hindrance to the free outflow of saliva, the gland atrophies, and in whole or part of it becomes a cyst.

The treatment is excision. When this is not practicable, the cyst may be opened and allowed by plugging to granulate up from the bottom.

SECTION XIV

SURGICAL DISEASES OF THE PHARYNX

By

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1. Acute infections and traumatic processes.
2. Chronic infections.
3. Hypertrophy of the faucial tonsils.
4. Neoplasms.

1. INFECTIOUS OR TRAUMATIC PROCESSES

By this term is denoted those inflammations of the tissues directly dependent upon bacterial, chemical or physical irritants.

The larger number of acute infections of the pharynx originate in the lymphoid tissue of the tonsils and of the posterior pharyngeal wall. Their clinical characteristics depend primarily upon the intensity of the irritation excited by the toxine generated as well as upon the localization of the microörganisms. Where the toxine is mild, the inflammation is a proliferative one, characterized by reddening and swelling of the mucous membrane, with emigration of leucocytes into the crypts of the lymphoid tissue. Where the toxine is stronger, the inflammation presents evidence of exudation, due to coagulation of the albuminous elements in the cells and in the surface fluids, being then characterized by the formation of a false membrane. If the microörganisms have penetrated below the surface of the tissue, they may undergo multiplication within the follicles, producing minute abscesses, which under ordinary circumstances proceed to develop in the line of least resistance, and eventually rupture into the crypts, with a consequent establishment of convalescence. If the rupture of these abscesses takes place, however, in the direction of the efferent lymph channels, the organisms are transported into the circumtonsillar fat tissue, under which circumstances an abscess formation or quinsy is probable. If the organisms penetrate further, they may cause swelling and suppuration of the cervical lymph nodes, or they may enter the circulation and cause inflammation of the joints, endocardium and kidney, or a general septicemia.

In ordinary forms of acute proliferative or exudative inflammation, the aid of the surgeon is not required. It may be possible at the outset to abort the disease through appropriate treatment, such as the administration of hexamethylenamine and the salicylates, with the local application of argyrol, collargol or silver nitrate. If, however, the condition is recognized only after the establishment of pronounced inflammation, such treatment may not shorten the duration of the disease, although the symptoms of discomfort may be considerably relieved. In fact active measures designed to sterilize the mucous surfaces may possibly actually prolong the period required for convalescence. It must be remembered that the recovery is effected under natural conditions through the establishment of an active immunity, induced by the absorption of a sufficient amount of toxine into the system, and the consequent formation within the system of antibodies. Anything, therefore, which tends to check the production of toxine, is calculated to prolong the period required for the manufacture of a sufficient quantity of antitoxine. The continued application of antiseptics consequently produces the reverse of what is sought to accomplish by the injection into the body of specific vaccines. The most important treatment which can be brought to bear upon the process is complete local and general rest. Local applications should be designed to cleanse the parts mechanically rather than to sterilize them.

If the inflammation has proceeded to abscess formation, this may be situated either within the tonsil, due to the coalescence of a number of the intrafollicular abscesses above mentioned, or in the circumtonsillar fat tissue.

In the first instance, reasonably prompt relief is apt to occur spontaneously through the rupture of the abscess into one or more crypts, and surgical intervention may not be necessary. On the other hand, if the abscess has developed in the neighborhood of the tonsil, it is bounded by relatively firm fascia which render spontaneous evacuation difficult, and incision may be consequently necessary. In the majority of instances the pus is nearest the surface at a point midway between the base of the tonsil and the condyle of the jaw, and is most easily reached by incising the anterior plica and dissecting around the capsules. For local anæsthesia one may introduce into the crypts, by a pliable silver cannula, a few drops of a dilute cocaine and adrenaline solution. This preparation is immediately taken up into the tonsillar tissue, and produces a marked diminution in pain, while if the abscess should be situated in the interior of the tonsillar tissue, the contractile

effect of the solution may cause an earlier spontaneous evacuation through the lacunæ.

Of the other infectious inflammations of the pharynx may be mentioned diphtheria, of which the surgical aspects will be considered under diseases of the larynx; influenza, typhoid fever, Vincent's angina, erysipelas and scarlet fever. In these conditions surgical treatment is not necessary, unless pyogenic complications develop under which circumstances they are to be treated along the lines already described.

2. CHRONIC INFECTIONS

Tuberculosis.—Of the chronic infections, primary tuberculosis of the tonsils is chiefly conspicuous as requiring surgical treatment. This condition is usually accompanied by a similar invasion of the surgical lymph nodes, and not infrequently involvement of the adenoid. Here a thorough excision of the tonsils and adenoid should be performed previous to any operation upon the lymph nodes of the neck, in order to close as far as possible this portal of entry.

Syphilis.—A frequent site for the initial lesion is the tonsil, which has derived a certain surgical significance from the practice of some physicians to excise the organ as soon as the disease is recognized. This procedure has not, however, found general acceptance. Secondary symptoms do not require surgical consideration. Of the tertiary lesions the gummatous infiltrations rarely require surgical intervention, unless in the later stages deformities occur, leading to interference with articulation or swallowing. Conditions vary here to such an extent that no general rules are possible. Most frequently one encounters cicatricial adhesion between the soft palate and posterior pharyngeal wall, leading to nasal occlusion, which may require division, with an attempt to secure an epithelial growth over the cut surfaces.

3. HYPERTROPHY OF THE FAUCIAL AND PHARYNGEAL LYMPHOID TISSUE

From birth until about the age of six, a rapid increase occurs in the number and size of the follicles of the lymphoid tissue in the pharynx, which remain essentially unchanged until puberty, when a diminution supervenes, leading to a progressive shrinking of the organ as old age is approached. During this whole period the lymphoid tissue experiences increase in size in response to various stimulations. Such stimulations may be physiological, as in the enlargement of the tonsils, accompanying dentition, or pathological and dependent upon the toxines of acute

and chronic infections. In certain instances the tonsils fail to undergo their normal process of involution and remain enlarged into middle and old age. In the examination of the tonsils, we have, therefore, first to distinguish between those hypertrophies which are likely to be transitory, and those in which no material change can be expected.

The indications for the removal of the tonsils are (*a*) harmful enlargement, (*b*) chronic inflammation, and (*c*) tendency to bacterial infection, conditions which may exist singly or in association.

(*a*) If the *enlargement* is sufficient to interfere with articulation, or with ventilation of the Eustachian tube, a partial or complete removal of the organ should be performed.

(*b*) *Chronic inflammation* of the tonsils may be accompanied by retention of débris in the lacunæ, leading to a variety of local and systemic disturbance, such as bad breath, indigestion and cervical adenitis.

(*c*) The lymphoid tissue of the pharynx and fauces may exhibit a *tendency to bacterial infections* which may be acute as in the pyogenic inflammations or chronic as in localized tuberculosis.

In the case of acute infections we have first to distinguish between occasional ones arising in virtue of a specially virulent type of microorganism and those infections which show a predisposition to recurrence, dependent upon local or systemic weakness on the part of the host.

Of these the first class is represented most typically by infections due to virulent strains of streptococci, as in scarlet fever and the septic sore throat from infected milk. These may involve both the tonsils, whether or not previously diseased, and the follicles of the adjacent mucous membrane.

Such cases do not, therefore, enter into our discussion of operative procedure.

In the second class of acute infections, namely those showing tendency to recurrence, there exists a primary vulnerability or diseased condition of the tonsils most frequently represented by chronic lacunar tonsillitis, favoring either local acute inflammation, as acute proliferative tonsillitis, intrafollicular and circumtonsillar abscess, or permitting the entrance of the infecting agent into the general system, and producing a variety of disturbances such as endocarditis, nephritis and arthritis. These types of tonsils call always for complete excision when possible.

The removal of the tonsils may be partial by a tonsillotomy or complete by a tonsillectomy. On the continent of Europe the former is

the operation of choice, particularly in children, a complete removal being reserved for conditions of general systemic infection, arising through the tonsils. In England and America, on the other hand, tonsillectomy is more frequently advocated.

In choosing the method of operation the following points are to be considered:

(*a*) Trauma.

(*b*) Septic complications.

(*c*) Hemorrhage.

(*d*) Alteration of the anatomical relationship of the parts involved.

(*a*) **Trauma.**—With reference first to tonsillotomy, the ideal operation removes as much of the tonsil tissue as possible without injury to the pillars, and leaves an area of lymphoid tissue to be covered in by granulations. This procedure is accomplished most typically by the various amygdalotomes, of which the knife moving in one plane leaves a flat, more or less circular wound, represented by lymphoid tissue, attached to the capsule of the organ. Consequently, the area of trauma and liability to subsequent deformity is reduced to a minimum. Unfortunately in the case of imbedded tonsils, these instruments are of little use, and the operator is obliged to employ punches to pass between the pillars, and reach the lymphoid tissue. Although such instruments should not increase the risk of deformity, yet since the area of a hemisphere is greater than that of a circle, the region of trauma is unavoidably extended, with consequent increase of post-operative inflammation.

Tonsillectomy may be done in a variety of ways, distinguished by the manner in which the capsule is separated from its surroundings. We may divide the methods for operation into two classes, namely, those in which the excision is performed chiefly by the use of relatively blunt instruments, and those in which the excision or the greater portion of it is accomplished by sharp knives or scissors. Experience has shown that the amount of inflammatory reaction subsequent to the operation depends to a great extent upon the character of the surface left. In general, the reaction is proportionate to the extent of necrosis supervening in the wound, particularly in the muscular tissues.

Since the necrosis is increased by overstretching and crushing of the parts, the manner of handling the instruments is of primary importance, and two operators with the same general technique may achieve entirely different results so far as the subsequent discomfort of the patient is concerned. For many surgeons the finger operation exposes

the patients to unnecessary trauma. While it is true that the use of a sharp instrument is less likely to be followed by reaction than a dull one, yet on the other hand, the cutting of vessels by a sharp knife is more likely to be followed by troublesome hemorrhage than if these are broken, twisted or cut with a dull instrument. I have, therefore, taken as the ideal tonsillectomy those methods by which the tonsil is dissected from the pillars and from the surrounding tissues by such instruments as will produce a minimum of trauma down to the point where the tonsillar artery enters, this spot being then cut through by the aid of a dull instrument such as a snare. It is, of course, assumed that the vessels in the pillars, so frequently the source of troublesome hemorrhage, are left intact.

In the Boston hospitals, the following method has been generally adopted.

After a hypodermic injection of morphine and atropine, proportionate to the patient's age (omitted in children), ether, introduced by nitrous oxide, is administered to a point immediately beyond the abolition of reflex action when the throat is touched. It is important not to exceed this degree of anæsthesia to any marked extent, as we wish the patient's control over coughing and swallowing to be within prompt reach when operative bleeding begins. When the proper stage of anæsthesia is reached, the gag is introduced on the right side by a good illumination from a headlight, the patient being in a sitting position, and the left cheek drawn outward to the left by the etherizer. The prepared snare is passed over the tonsil forceps and allowed to hang free, while the forceps seize the right tonsil and draw it slightly out of its bed. A small sharp tenotomy knife performs the dissection from above downward, the cutting edge being used at first, and often later, as occasion requires, the back of the point, in order to avoid cutting the pillars or the lymphoid tissue itself.

The dissection proceeds rapidly down to the point where the tonsillar artery enters, when the tonsil is lifted upward, and a horizontal cut is made, delimiting the organ from the lingual lymphoid tissue. The snare, which in the meantime has been hanging free, has now only to be slowly closed to cover the region of the artery and the tonsil comes away in the forceps. The procedure is then repeated for the other side. The size and shape of the knife blade is of the first importance, only a small one, which can be easily turned in the hand, and made to cut as described, front or back, meeting the requirements. The hypodermic injection of morphine and atropine serves the purpose of keep-

ing the field of operation dry, and diminishing subsequent pain. The headlight permits accurate manipulation of the knife, and renders one independent of the varying conditions of daylight and of the presence of spectators.

(*b*) In the consideration of the relation of sepsis to tonsil operations, an increased frequency of late years is evident, due both to more radical methods of operating, and to the fact that we are now removing tonsils more often than before for conditions which in themselves favor the occurrence of systemic infection. For many operators it is true that a greater amount of trauma and inflammatory reaction follows their present operations of tonsillectomy than occurred after their earlier tonsillotomies.

Since greater inflammatory reaction is apt to follow the removal of tonsils which are in themselves essentially septic (a reaction which seems often unavoidable) it is especially necessary to operate with care, to avoid stretching of the parts, and to leave the wounded surface as clean and smooth as possible.

(*c*) Post-operative hemorrhage may immediately follow the operation, but occurs most frequently several hours later. Rarely it may appear after several days. If it proves troublesome directly after the operation, it may often be treated sufficiently by removing the clot from between the pillars, and applying pressure for a few minutes to the bleeding area with a bit of styptic cotton. If this is not sufficient, or if the throat is intolerant, approximation of the pillars may be done either with Michel's clamps or by passing one or more stitches through the pillars by means of a curved needle. The clamps or stitches are applied deeply enough to approximate the pillars close to the bleeding vessel. The former have the advantage of being readily applied without general anæsthesia, and are easily removed in 24 hours.

(*d*) With reference to the conservation of the anatomical relationships of the parts involved, tonsillotomy by its nature should produce no gross deformities, and yet it is frequently the cause of a serious result, namely, the narrowing or occlusion of the lacunar orifices, which are left in the stump of the tonsil. This leads to the accumulation of detritus in the crypts with resultant absorption of decomposing material. Since tonsillectomy produces a more extensive wound, it may, if improperly done, produce deformity. The pillars may be cut or torn away, or they may become fused, or a stellate cicatrix may occur with resulting puckering and retraction of the parts. Such alterations of structure may have harmful consequences for voice production.

4. NEOPLASMS OF THE PHARYNX

Benign Tumors.—True tumors may arise from the ectoderm, producing papilloma or adenoma, or from the mesoderm, giving fibroma, lymphoma, myxoma, chondroma, osteoma and angioma. Of these the most frequent in the pharynx is papilloma, characterized by the presence of numerous fibrous branches covered by epithelium. In spite of its similarity to cancer, on account of its tendency to active atypical proliferation, the non-malignant character is shown by the fact that the epithelium covering the tumor is sharply limited below, and does not at any place penetrate the underlying tissue. The growth is to be distinguished from papillary hypertrophy found at times in the tonsils, in which all the elements of the mucous membrane participate. Adenoma is found rarely in the palate, where it may be associated with dilatation of lymphatics. Fibromata are rare in the pharyngeal regions, although of frequent occurrence in the nasopharynx. Lipomata have been observed upon the mucous membrane of the tonsils. They consist in a center of fat tissue, surrounded by more or less abundant connective tissue in the peripheral portions and are covered with the mucous membrane of the parts. They are apt to be associated with other growths, particularly fibromata and myxomata. The fat tissue in these growths is distinguished from normal fat tissue from the greater size of its cells and lobules. It may be associated with greater development of fibrous tissue, producing a fibrolipoma. In the tonsils, cystic growths may arise from the occlusion of a lacuna following inflammation or tonsillotomy, and may give rise to suspicion of a new growth until incised. The walls of such cysts are formed of flattened epithelium and the contents consist of fat drops, plates of cholestearin, exfoliated epithelium, and leucocytes. Tumors of the lymphatics from stasis have been reported from the pharynx.

Malignant Tumors.—Of these we may distinguish two chief types, according as they arise from the ectoderm (or entoderm) or from the mesoderm, the former being represented by carcinoma, the second by sarcoma. In the pharynx, carcinoma occurs with relative frequency, particularly in the region of the tonsils. It may also occur upon the tip of the uvula as a primary growth in this situation. The only treatment is surgical removal, if possible, together with the lymph nodes of the affected side.

Sarcoma.—These tumors consist to a greater or less extent of immature forms of connective tissue, produced through proliferation of cells of mesodermal nature. The growths may assume clinically either

the form of a sarcoma or of a malignant lymphoma. The majority of writers now consider that no essential resemblance exists between malignant lymphoma and Hodgkin's disease, and that often no sharp line of demarcation can be found to separate these conditions from sarcoma and lymphosarcoma. For clinical purposes it is convenient to separate the cases into the typical forms, and we may say that by the term pseudo-leucemia (Hodgkin's disease, malignant lymphoma) is denoted a condition characterized clinically by progressive enlargement of the various organs of the body in which lymphadenoid tissue occurs, extending by the way of the lymph channels from one group of glands or nodes to those in contiguity, and exhibiting histologically a proliferation of the reticulum and marked increase of fibrous tissue, associated with numerous lymphocytes. By sarcoma of lymphadenoid tissue (synonym, lymphosarcoma) is denoted a malignant enlargement of such tissue, exhibiting clinically a tendency to invade the organs in the immediate vicinity, and characterized histologically by a replacement of the normal follicular structure by numerous round cells with a small amount of endothelial reticulum.

The *prognosis* in these conditions is unfavorable. The X-ray has been reported to be of service in some instances of lymphoma.

In rare instances spontaneous recovery has been noted. In one case of lymphosarcoma of the author's, complete recovery followed the use of staphylococcus vaccines, in connection with the hypodermic administration of turpentine, the latter being for the purpose of producing suppuration below the skin. The use of the staphylococcus vaccines has been found helpful also in Hodgkin's disease with localization in the neck and fauces.

Coley has observed marked improvement and some apparent cures in sarcoma from the use of vaccines of streptococcus pyogenes and bacillus prodigiosus.

Malignant growths of the faucial pillars, uvula and tonsils, if recognized sufficiently early, while still sharply circumscribed, may be completely excised through the mouth. In the case of the tonsils this procedure is seldom sufficient as the cervical lymph nodes are involved so promptly that their simultaneous excision is essential. Under these circumstances we may have recourse to subhyoid pharyngotomy, or to lateral pharyngotomy.

Subhyoid Pharyngotomy.—A transverse incision is made at the level of the hyoid from one horn to the other. The sternohyoid, thyroid and omohyoid muscles are cut through as close as possible to their at-

tachments to the hyoid, in order to avoid the superior laryngeal nerve. The thyroid membrane is thus exposed and is incised along its attachment to the hyoid bone. With the finger, the operator can now push the glosso-epiglottic fossa forward and downward, exposing the pharynx freely, and permitting the removal of the diseased portions of pharynx and tonsils. Kocher recommends the thermocautery in preference to scissors, as being less likely to be followed by metastases. In closing the wound it is advisable to leave a tampon of iodoform gauze, so as to extend as far as the deep sutures. A tracheotomy may be necessary on account of the secondary œdema of the glottis.

Lateral pharyngotomy is recommended for removal of extensive growths of the tonsils and pillars. After preliminary tracheotomy, an incision is made from the mastoid process to the middle of the hyoid bone. The auricularis magnus nerve and the jugular vein are cut if necessary, the anterior facial, jugular vein and external maxillary artery are tied and cut; the submaxillary gland extirpated and the lingual pharyngeal and palatine arteries tied at their point of origin. It is thus possible to draw the large vessels of the neck backward and the hypoglossal nerve upward. The incision now proceeds along the inner aspect of jaw, and the pterygoid muscle toward the pharyngeal mucous membrane, leaving, however, intact as far as possible the nerves supplying the muscles which move the hyoid and larynx. This is best done by cutting the digastric and stylohyoid at the hyoid attachments, and the styloglossus near the tongue. Finally after the separation of the stylopharyngeus, the hyoglossus and mylohyoid from their hyoid attachment, the external pharyngeal wall lies exposed. The growth can then be removed together with whatever glands may be involved.

SECTION XV

NOSE

By

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EXTERNAL NASAL DEFORMITIES

Aquiline or Hump Nose.—Disfiguring prominence of the nasal bones can be removed internally or externally. An internal operation under general anæsthesia is preferable. For this procedure, douche the nose with normal saline solution, then introduce the sharp end of the author's septal elevator (Fig. 125) into either nostril until it impinges upon the inferior edge of the nasal bone of that side, engaging the tissues and working the elevator through until it is between the periosteum and the nasal bone. Now reverse the elevator, and continue the dissection with the dull end (which is made of copper and which can be bent to any curve necessary to fit the case), until all the periosteum is free from the hump, then introduce the author's draw chisel (Fig. 120) and pare the

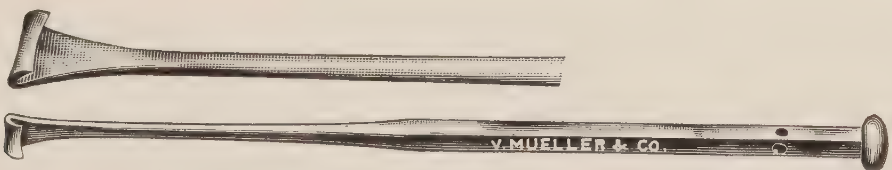

Fig. 120.—This chisel fits the universal handle of Myles' draw chisels.

hump down slightly lower than the requirements, as there will be some thickening from callous and fibrous tissue produced. Douche the cavity with normal saline solution to remove the débris, and mould to the nose a pad of dental gutta-percha, softened in hot water; afterward harden the mould in cold water. This pad will prevent hemorrhage and is held in place with strips of adhesive plaster placed across the face.

A possibility of sepsis, because of the difficulties of sterilizing the interior of the nose, is the one objection to this procedure. In five cases I have had one infection, causing a thickening which was as bad as the original deformity.

External Method.—An incision, a little longer than the prominence to be reduced, is made through the skin and periosteum, vertically along the angle of the anterior and lateral planes of the nose. The periosteum

is elevated, the hump is removed with sharp chisels and the flaps coapted with adhesive plaster. This procedure leaves a scar which is hardly noticeable.

Displacement of the Nose, Laterally.—This deformity, when it involves the nasal bones, is usually the result of violence and is rarely a congenital condition. Where the nasal bones are displaced to one side, the bone on the side of the displacement usually over-rides the superior maxillary bone and the opposite bone is depressed. In correcting this deformity, the object is to freely loosen the bones, to replace them, and then to hold them firmly until united, for doing which, the heavy Asch forceps is applied to the nasal bone, one blade being

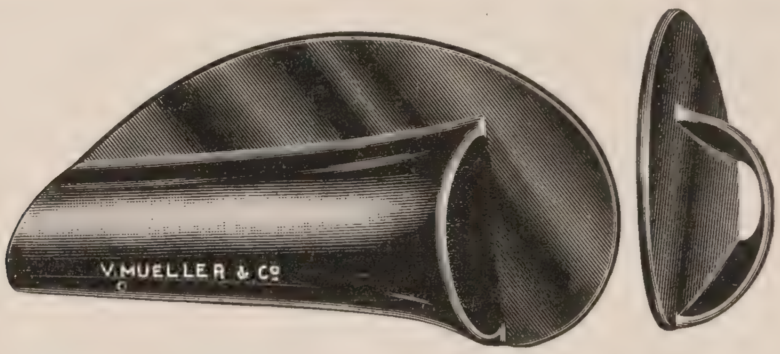

Fig. 121.—Hard rubber intranasal splints used in fractures.

introduced into the nose and the external blade being covered with rubber tubing to prevent injury to the skin. The nasal bone is now grasped firmly and rotated until free from its attachments. The same is done to the opposite nasal bone; then the septum is grasped with the forceps and fractured just under the nasal bones. The bones should now be sufficiently pliable to allow of being placed in position and to remain so without support. In some cases, however, the depressed bones need some support in the nose to hold them in place. A small quantity of gauze, packed in the nose under the nasal bone will usually give the necessary aid. Sometimes a stronger support than this is required; then a hard rubber nasal splint (Fig. 121) can be used in one or both of the nostrils for a few days until the bones become fixed in their new positions. A lateral displacement of the tip of the nose is due to the distortion of the septal cartilage. Correcting the septal deviation by a submucous resection will tend to bring the nasal tip into the median line.

Saddle or Deformed Nose (Fig. 122).—This condition is usually caused by syphilis, atrophic rhinitis, abscess of the septum, cretinism and occasionally by trauma, and can be easily corrected by injecting paraffin (Fig. 123), though not without danger as part of the paraffin may escape

into the blood-stream and cause emboli in the lungs, coronary arteries or the central artery of the retina (several cases of unilateral blindness have been reported).

FIG. 122.—Saddle nose (traumatic).

FIG. 123.—Same after paraffin has been injected.

The Technique of Paraffin Injection.—Perfect asepsis is necessary. Special paraffin, melting at 110°F. (cold in its solid state), is injected by means of a special syringe (Fig. 124). The needle is introduced either at the root of the nose or at the tip and pushed along under the skin until its point is at the further end of the depression. At this point an assistant, standing behind the patient, puts pressure with his thumbs on the sides of the nose to prevent extravasation of the paraffin toward

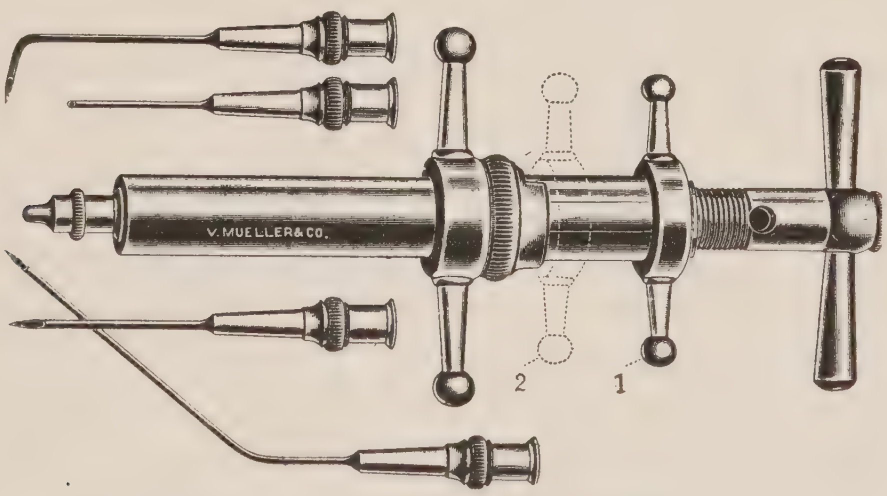

FIG. 124.—Paraffin syringe. (*Broekaert.*)

the cheeks. The operator now slowly injects, at the same time gradually withdrawing the needle and injecting a little more than is necessary as eventually there will be some shrinkage. Another precaution is to cease injecting as soon as the pressure of the paraffin causes blanching

of the skin, otherwise the pressure will cause a slough. It is better to inject more paraffin later.

To build up the nose from depressions in which the nasal bones have been fractured and have over-ridden the nasal processes of the superior maxillary, it is necessary to refracture or loosen the nasal bone or fragments freely and to bring them back into their original place, fixing them until they unite. Sometimes, as in a recent fracture, this can be accomplished by the use of a small amount of gauze packed in the anterior part of the nose or by special splints, as illustrated, which permit of nasal breathing while the repair is taking place.

Depressions resulting from loss of bone or cartilage, especially of bone, require replacement of bone which can be done best by resecting a piece of the patient's ninth rib, about 2 in. long (Carter's method) and trimming this piece of bone down till it fits the requirements of the nose. The nose is prepared for the reception of the piece of bone from the rib by making a transverse incision, ½ in. long, between the eyebrows. Through this incision, the tissue down over the bridge to the nasal tip being loosened with a narrow knife, the piece of well-trimmed bone is then slipped in, and the incision is closed.

Deformities in which a portion of the soft tissues as well as the bone and cartilage have been destroyed, require the transplantation of tissue from some part of the body. Where soft tissue only is required, a flap can be cut from the forehead down to the periosteum, with the base of the flap toward the root of the nose. Make the flap at least ½ in. wider and considerably longer than necessary to fill up the gap to allow for shrinkage. The required shape of this flap from the forehead is best cut by outlining a pattern of the part of the nose to be filled in, and then reversing this pattern for making the forehead flap. When the flap is turned down to be sutured in the nasal defect, the pedicle should not be severed for ten days; then it should be divided the nasal portion being sutured into the upper part of the defect and the balance replaced in the forehead by opening the old incision sufficiently. Where bone and soft tissue are required, a finger can be transplanted, or better still, a section of a rib can be transplanted under the skin of the arm, remaining there until it becomes a part of its new position. A flap, including this piece of bone, is then made and the arm is brought up to the nose and held there by means of a plaster cast, the edges of the flap being sutured to the nasal defect, and the arm being held in place until the union is completed; then the flat pedicle is severed and sutured to the base of the nasal defect.

Bulbous Nose.—Where the tip of the nose is abnormally large, the tip can be made narrower by removing portions of the superior and inferior lateral cartilages from within the nose. Small, right-angle, aural knives, introduced through the nasal mucosa and cartilage, will outline the amount of cartilage to be removed; usually an elliptical excision is sufficient to reduce the size.

Recent Fracture.—In recent fracture of the nasal bones, anæsthetize the nasal mucous membrane; introduce some straight instrument like a periosteal elevator into the nose, lift the bones into place and pack antiseptic gauze into one or both sides of the nose, as need be, to hold the bones in place, the small amount of gauze is pushed up anteriorly under the nasal bones. The fractured bones remain in position without packing after 48 hours.

Long or Parrot Nose.—This can be corrected by simply removing a V-shaped piece from the cartilaginous portion just below the nasal bone and pulling the tip up with sutures and adhesive plaster.

Anæsthesia.—In all operations upon the nose, the most important preliminary, after the patient's health has been considered, is the anæsthesia. All the intranasal operations can and should be performed under a local anæsthesia, because the operative field is more bloodless. In the case of nervous and apprehensive patients, for several years I have pursued the plan of giving morphine, gr. 1/8 and hyoscine, gr. 1/100, 60 minutes before the time of the operation, and if necessary, to quiet the patient, I repeat the dose in half an hour. The nose can be easily anæsthetized with a 10 per cent. solution of cocaine, or one of its substitutes. Personally, I prefer alypin, 10 per cent. solution, on account of its less toxic qualities. To both solutions, there should be added five drops of adrenalin to the dram of the anæsthetic, which solutions are easily applied to all of the ramifications of the nasal cavity by the compressed air spray, the patient's head being bent well forward while spraying so that the excess of the solution may drain out of the anterior nares rather than run backward into the throat where it causes considerable annoyance. Use three applications of the spray with an interval of a few minutes between each one, which will allow the first application time to contract the mucous membrane and the subsequent applications will act on the deeper parts. After an interval of 10 minutes the nose will be found to be completely anæsthetized and the patient quite indifferent after the preliminary administration of the morphine and hyoscine. If the operative field includes any of the nasal sinuses, a solution of alypin and adrenalin should be injected by means of a cannula.

DEFORMITIES, INTERNAL

Deviation of the Septum.—Deviation of the septum, which is sometimes traumatic, is usually due to unequal development of the bony frame of the face. The traumatic conditions can be easily distinguished by the acute angles in the septum, and they rarely extend beyond the quadrilateral cartilage. The deviations take on many forms, the most

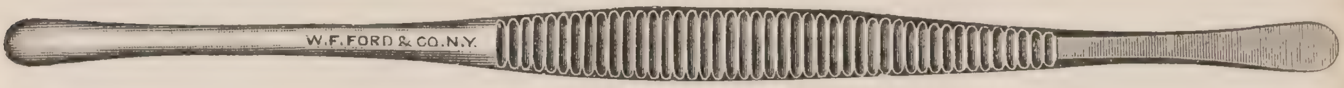

FIG. 125.—Elevator, one end of copper, which can be bent readily to any desired curve.

frequent being along some one or more of the articulations of the vomer, perpendicular ethmoidal plate and quadrilateral cartilage. Nearly every nasal septum is more or less out of the median line, and may be considerably deviated without giving symptoms. Impaired drainage of the nose or accessory sinuses and poor ventilation of the nose are sufficient causes for surgical interference, the impaired drainage causing infection of the accessory sinuses, recurrent coryzas, and chronic

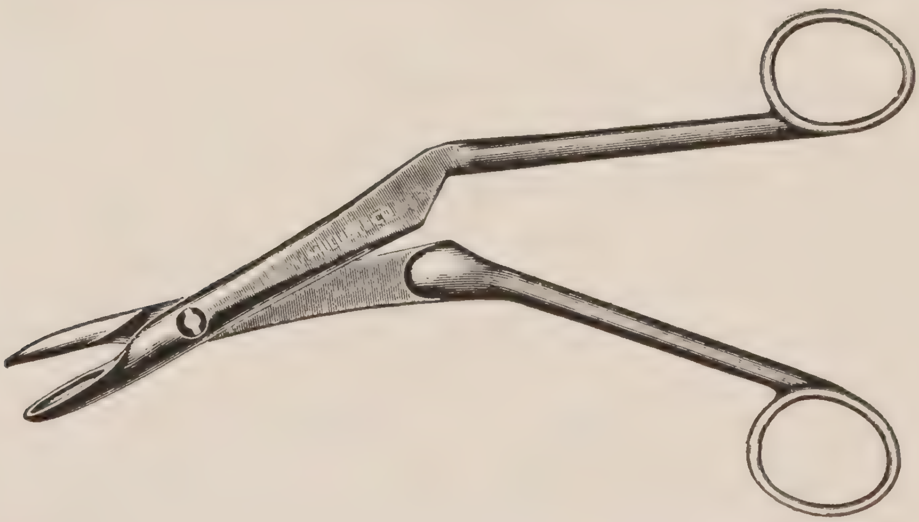

FIG. 126.—Heavy forceps for resection of the nasal septum.

rhinitis, while the obstruction to the air current often induces catarrhal conditions of the Eustachian tube and middle ear, and may also cause more or less change in the larynx, trachea, and bronchi. Pressure of the deviated septum against the outer nasal wall is occasionally accountable for indefinite sensations in the orbit and for eye-fatigue, and may also cause neuralgia and headache. The deviation should not be corrected during an attack of acute coryza, acute otitis media or diabetes, but in the case of an acutely infected sinus, an operation might be considered, under stress for drainage.

Technique.—The preliminary anæsthesia as previously described, is advised. A few special instruments are required, namely, elevator (Fig. 125), two or three special forceps (Figs. 126, 127, 128), a speculum (Fig. 129), a right-angle knife, and a curette.

FIG. 127.—Down-cutting forceps for septal resection.

For doing the resection, a curved incision is made down to the cartilage, always on the convex side and in front of the deviation, where the septum is in the median line; then the muco-periosteum is elevated over the convex surface as far as the deviation (Figs. 130, 131, 132) extends. With a curette, starting well up just posteriorly to the incision, a strip of cartilage is removed down to the floor. This is easily and safely done by holding the curette like a pen and slightly rotating it on its long axis as the curette engages the cartilage. The muco-periosteum is elevated on the concave side through the window in the cartilage. The membrane is elevated easiest in the superior portion which should be done first, then from this space, starting well posteriorly, elevate the membrane downward and forward. It will be found that the lower part of the membrane can be detached without fear of perforations, if done from behind forward. In elevating the concave membrane, it is best to watch the progress of the elevator under the membrane by looking into the nares of the concave side. The deviated cartilage and bone are now

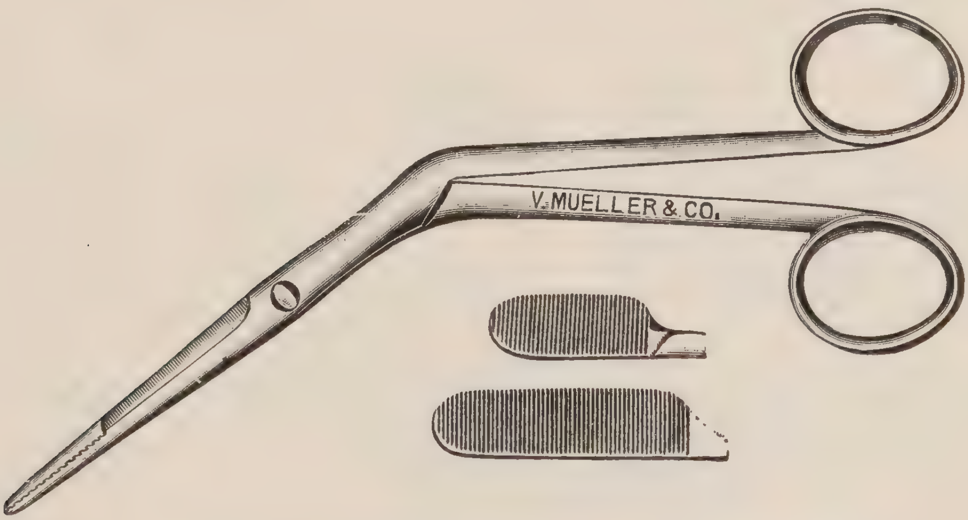

FIG. 128.—Killian's duck-bill forceps for resection nasal septum.

ready to be removed with the large biting forceps, and the work is greatly facilitated by using the special septal speculum which keeps the two membranes well apart, and permits a better view of the operative field. The cartilage and bone should be entirely removed wherever they are out of the median line, as partial

FIG. 129.—Speculum with short and long blade, used to retract the septal membrane.

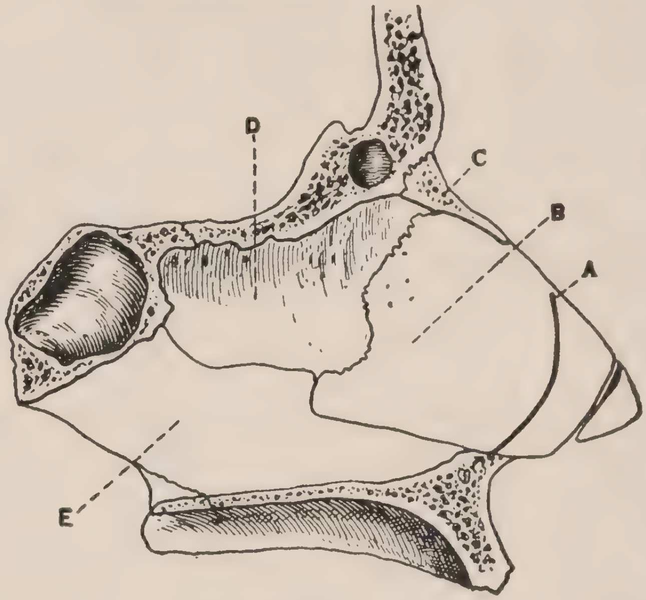

FIG. 130.—The nasal septum. *A*, Curved incision; *B*, Quadrilateral cartilage; *C*, the nasal bone; *D*, perpendicular plate of ethmoid; *E*, the vomer.

removal will later cause a vibration of the septal membrane during respiration which is annoying to the patient. With the cartilage and bones removed, the membranes fall into apposition, and for a time packing is necessary to hold them in place. The method is to pack

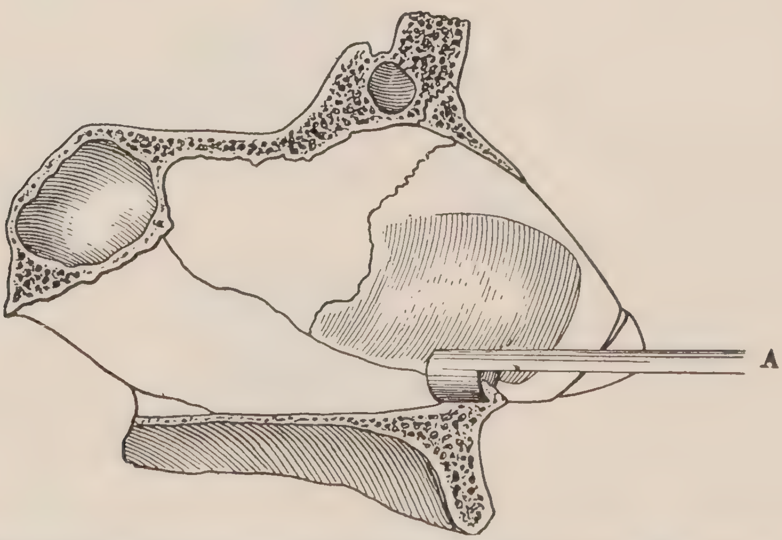

FIG. 131.—The shaded portion represents the portion of the septum removed. *A* shows the down cutting forceps engaging the anterior nasal spine.

plain gauze inside a rubber condom sufficiently tight to keep the two membranes together, which packing is removed after 24 hours; first remove the gauze, then the rubber bag will collapse.

Hypertrophied middle turbinates that obstruct drainage of the ac-

cessory sinuses or cause stuffiness and pressure across the nasal bridge should be removed (Figs. 133, 134, 135, 136), which is easily done with nasal scissors (Beckmann's) and a snare. Introduce the scissors, one

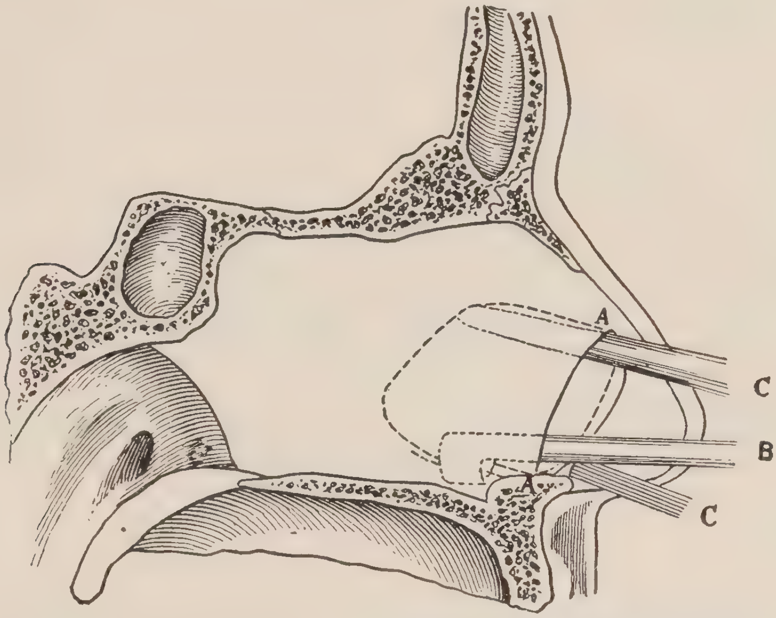

FIG. 132.—*A,A'* shows the incision held open by the long blade of the speculum. *C,C'*, Dotted enclosure, indicating the amount of the septum removed. *B,B'* shows the down-cutting forceps.

blade into the olfactory fissure and the other blade at the anterior attachment of the turbinate with the outer nasal wall, pushing the blades upward and backward as far as they will go without resistance,

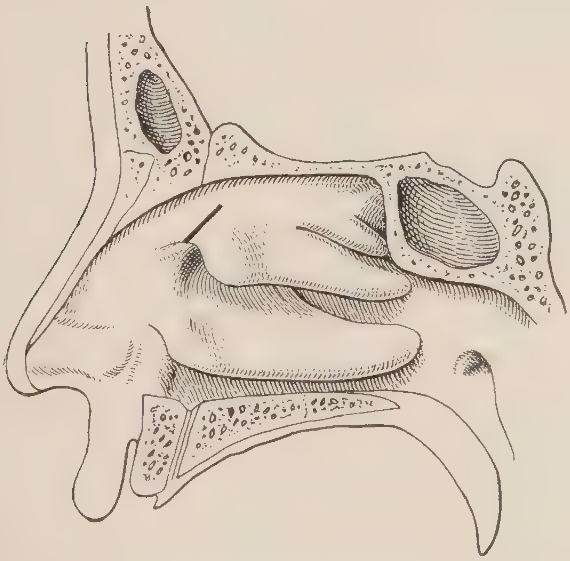

FIG. 133.—First cut with scissors, upward and backward.

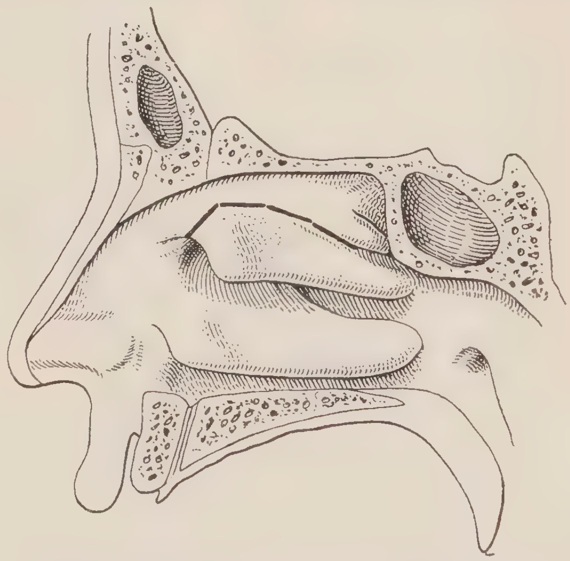

FIG. 134.—Successive scissor cuts.

about ¼ in. Divide the tissue, then depress the scissors' handles so that the blades will fracture the middle turbinate along its attachment. Carry the blades of the scissors in a backward direction, severing more of the attachment, and again depress and so on with small cuts until the

turbinate is hanging only by a small posterior portion. Now pass the snare loop around the hanging portion with the cannula above until the loop engages the portion remaining attached, and snare off.

Enlargement of the inferior turbinate may be divided into the hyperplastic and the hypertrophied forms.

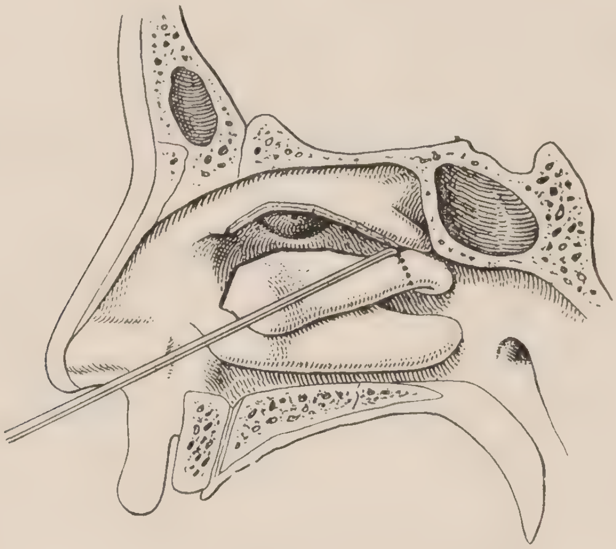

FIG. 135.—Removal of the pedicle with the snare.

The hyperplastic variety is frequently secondary to some local derangement, such as the septal deviation, or to a general condition, such as an excess of uric acid, the alcoholic habit or the unstable vasomotor conditions. Aside from correcting any primary local cause, the

FIG. 136.—Beckmann's scissors for the removal of the middle turbinate bone.

most successful local treatment is the use of the electric cautery at cherry-red heat. About three linear cauterizations are sufficient (Fig. 137). The cautery blade is passed to the posterior end of the turbinate, and with the current now turned on, it is drawn slowly and smoothly forward, first along the inferior border, then along the middle, and again near its upper portion. Avoid using the cautery too hot (cherry red). A slow and steady motion while burning will seal up the vessels and

leave a dry field. Lack of these precautions may lead to troublesome hemorrhage, requiring packing.

The hypertrophied variety feels firm to the probe, will not diminish materially in size under cocaine and adrenal in solution, and is most

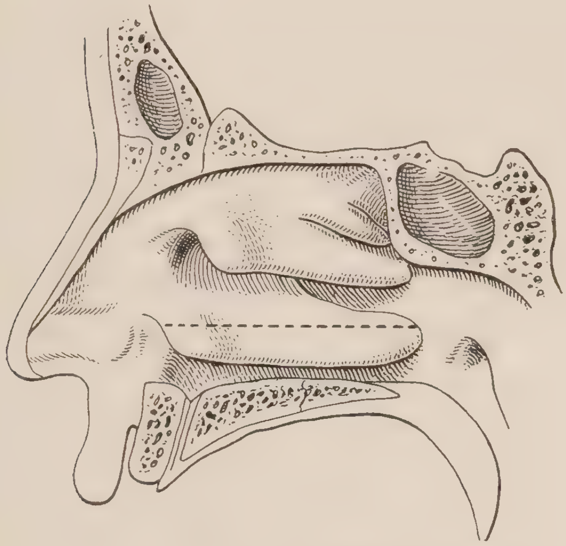

FIG. 137.—Lines for applying electric cautery.

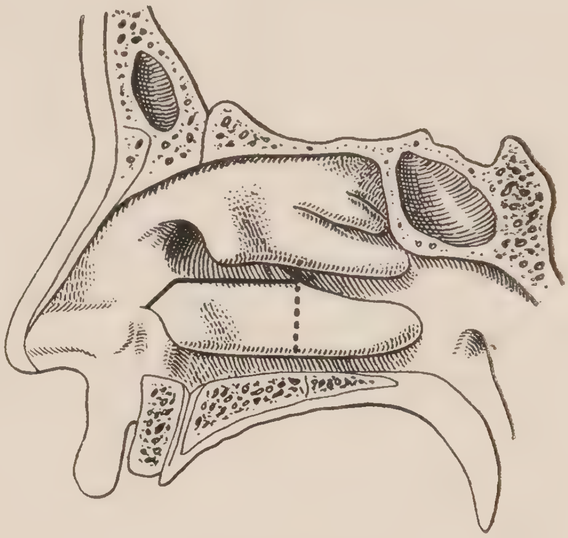

FIG. 138.—Line of incision in partial inferior turbinectomy.

advantageously corrected by removing all portions that obstruct the nose, from before backward, with heavy scissors (Fig. 138) or von Struychen's forceps (Fig. 139), which instrument meets these conditions

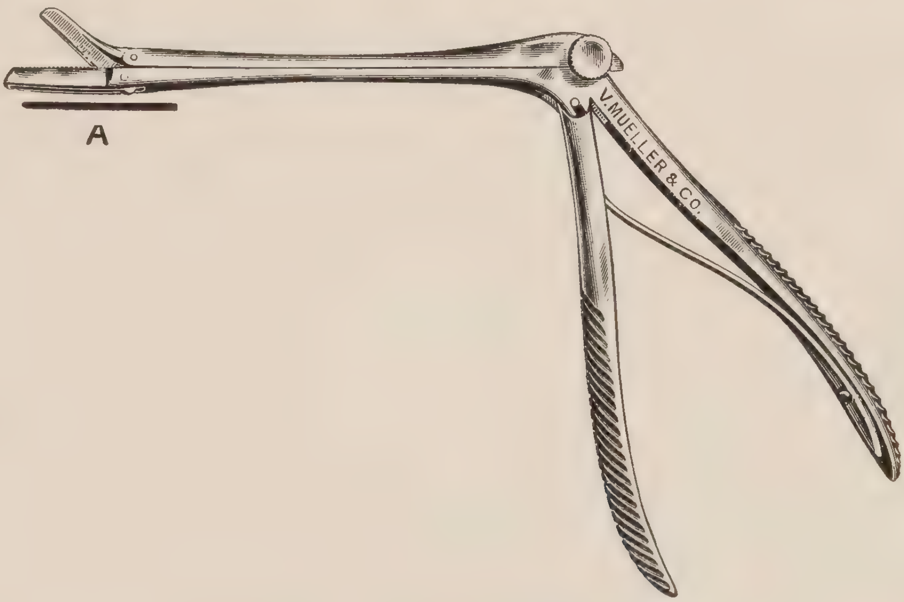

FIG. 139.—von Struychen's forceps.

best. After the removal of all the obstructive portions, the nostril should be firmly packed with antiseptic gauze. First place a strip of gutta-percha over the denuded area to prevent the adherence of the gauze, thus avoiding severe hemorrhage at the time of removal.

Enlargement of the posterior portion of the inferior turbinate frequently occurs, and is usually secondary to some obstruction of the nose such as a deviated septum, the enlargements generally subsiding after correcting the primary cause. When they fail to subside, they may be snared off by engaging the posterior portion of the inferior turbinate with a wire loop, bent at an angle with the snare cannula, but this is rarely necessary.

Perforation of the septum rarely causes trouble. It is due to syphilis, typhoid and other infections. It may also be produced surgically, and sometimes by the persistent use of the patient's fingernail, attempting to remove an obstruction or crust on the cartilaginous septum. If the crust is sufficient to cause annoyance, it can usually be remedied by reducing the edge of the perforation through removal of the cartilage and bone between the membranes for one-fourth of an inch. The various methods of using a flap of the septum to cover the opening usually fail.

Atresiæ and adhesions in the nasal cavities, due to syphilis or careless use of caustics, are relieved by the general principle of dividing the bands and interposing some non-irritating material, such as gutta-percha, until the surfaces heal.

INFECTIONS

Furunculosis of the nasal vestibule is an infection of the hair follicles, and is generally associated with intestinal fermentation or complicating purulent processes in the nose. The symptoms are swelling, redness and tenderness of the nasal tip. Incision of the abscess within the vestibule will promptly relieve any particular furuncle, but as it is quite liable to recur, the condition of the general health often needs consideration.

FIG. 140.—Bulging of the septum from hematoma or abscess.

Acute abscess of the nasal septum is usually the result of trauma, erysipelas, or an infective fever such as typhoid, scarlet, etc. (Fig. 140).

Symptoms are the history of trauma with evidence of external violence, pain and tenderness of the nasal tip, nasal obstruction, headaches and general malaise, with at times rise of temperature. On inspection, the septum is bulging, filling the entire nasal cavity in front on both sides, the eyes may be congested, and there may be swelling of the under lid and of the entire face.

Diagnosis is easy, as the history of short duration with the swollen

septum is rarely due to anything else, and if incised early, more blood than pus will be found. I have never seen a simple, chronic abscess of the septum, and I believe them to be very rare.

Prognosis is good regarding the extension and the development of the general sepsis, but poor from a cosmetic point of view. There will be a depression in the nasal profile just below the nasal bones from the accompanying chondritis if not promptly and intelligently treated.

Treatment.—After anæsthetizing both sides of the septum, make a liberal incision in each side, avoiding later perforations by not making these ncisions opposite each other; then through these incisions inspect the cartilage, removing all that appears infected, the prompt removal of which prevents extension of the chondritis and the possible resulting deformities. As the hematoma from trauma quite regularly breaks down, the earlier it is opened the better. Keep the septal flaps apart with iodoform gauze and treat as an open wound.

Diphtheria.—Primary diphtheria of the nose may be acute or chronic. The acute cases have little or no febrile symptoms. The nose secretes a foul serous discharge which is sometimes sanguineous, while the nasal orifice is inflamed and there is occasionally epistaxis. The membrane may be located at any place within the nose, generally covering most of the mucosa and rarely extending from the nose to the upper lip, or backward to the throat. It is gray in color and sometimes stained brown with blood. It is quite adherent, and its removal causes bleeding. When the infection remains nearly a pure Klebs-Lœffler, the symptoms may run a benign course except in the case of infants, who seem to bear this nasal infection poorly. In cases in which there is a mixed infection of streptococci and staphylococci, the course of the disease is severe. The average case that the rhinologist sees is a diphtheria carrier, and the patient seems immune to extension of the infection which runs a subacute or chronic course without general symptoms.

Diagnosis.—Nasal diphtheria may be confounded with membranous rhinitis, but in the latter the membrane can be easily detached without hemorrhage, and there is little or no odor to the discharge. The findings of a bacteriological culture will clearly decide the question.

Treatment.—Antitoxin is indicated, although it does not act as promptly as in the case of faucial diphtheria. Saline douches should be employed locally. Antiseptic douches seem to prolong the infection.

Epidemic Influenza.—This infection frequently involves the nose and nasal accessory sinuses, the attack often beginning as an acute

coryza promptly followed by the constitutional symptoms, or the nose may become involved in the course of the disease. In the beginning the nasal mucous membrane becomes thickened, reddened, very sensitive, and dry, after which a thick secretion forms. There is intense headache and anosmia, with involvement of the sinuses which increases the pain and headache. First, the ethmoidal cells are usually involved, then one or all of the frontal, antral, or sphenoidal sinuses, with the accompanying pain, tenderness, and eye symptoms as described under acute sinus disease. As the thickening of the nasal mucous membrane is not materially relieved by local applications, it is desirable to use only mild and non-irritating treatment, such as employing warm saline douches, oil sprays, and the external heat from leucodescent lamps, hung near the infected parts, which heat will relieve the pain more effectively than the heat from a hot-water bag. The accessory sinuses often will be found secreting pus months or even years after the acute symptoms of the influenza have abated, the anosmia or parosmia persisting, especially in the cases with purulent secretion from the sinuses; the anosmia, when due to the presence of pus, subsides after the sinuses are well, but the prognosis is poor if the loss of smell is directly due to the influenza infection. The treatment of the chronically infected sinus will be considered under "Sinuses."

Pus Organisms in General.—The staphylococcus pyogenes aureus, citreus and albus, various forms of streptococcus, micrococcus pneumoniæ (Fränkel), bacillus of pseudodiphtheria, bacillus fœtidus, diplococcus ozenæ, colon bacillus, Friedlander's capsule bacillus, meningococcus intracellularis, and the influenza bacillus have all been found in purulent conditions of the nose. Pus in the nose is strong evidence of sinus involvement, which is generally a mixed infection involving some of the sinuses, as a purulent secretion rarely is limited to the nasal mucous membrane.

Typhoid.—The nasal mucosa frequently exhibits passive congestion during typhoid fever, and in the last stages of the disease ulcers may appear upon the septum and at times upon the turbinates. The septal ulceration is apt to be deep, involving the cartilage and bone and resulting in perforation of the septum.

Tuberculosis of the Nose.—This infection is quite rare. A granuloma with a sessile base may be found upon the septum, which is generally pink or gray in color, and has a granular surface which cannot be distinguished clinically from a syphilitic granuloma, a section of which growth, under the microscope, will show the presence of giant

cells or of miliary nodules containing the giant cells, which microscopic findings could hardly be considered as final in the determination of the question as to syphilis or tuberculosis, as such features are sometimes present and sometimes absent in both of the diseases. It is scarcely necessary to mention that caseation and other degenerative processes occur in syphilis as in tuberculosis, and that the presence or absence of these retrogressive metamorphoses do not constitute a distinctive sign between these diseases; nor is the production of connective tissue, which leaves familiar scar-formation, a reliable sign.

Arteritis, leading to vascular obliteration, is often quoted as a characteristic feature of syphilis, and as a matter of fact this condition is almost constantly found. However, this vascular change is not entirely conclusive, as it is met with in tuberculous conditions as well, the giant cells in syphilitic lesions perfectly resembling Langerhans' giant cells met with in tuberculosis. Some medical authors maintain that the giant cells originate by individual growths from a single cell, while others assert that several cells are concerned in their growth. The general tendency seems to be to regard them, on account of their parietal nuclei, as cross sections of preëxisting vascular or lymph channels. But whatever their true origin, it may be assumed that they are the same in both tuberculosis and syphilis. The only conclusion then that can be drawn is that the microscopical and the clinical pictures cannot be absolutely relied upon. Unless the tubercle bacilli can be demonstrated in the tissues or by inoculation, we should consider the condition as syphilitic. The ordinary doses of mercury and potassium iodide will show poor results in these granular conditions, the administration of doses to the point of toleration for a lengthy period of time being needful for satisfactory results.

Lupus of the nasal mucosa has the same characteristics as that on the skin about the nasal orifice. This condition is rare in the native born.

The treatment of nasal tuberculosis is to remove as much of the infected area as possible with the curette or with the electric cautery.

Syphilis of the Nose.—Primary lesions within the nasal orifice occasionally occur from a contaminated finger or surgical instrument. They appear usually upon the septum, but sometimes deeper, especially when caused by unsterilized instruments, such as a Eustachian catheter, the chancre being usually painless, unless the swelling causes pressure. The swelling is circumscribed, ulcerates rapidly, and the submaxillary

lymph-glands become slightly enlarged, freely movable, hard, and painless; the secondary symptoms resemble a simple coryza and are characterized by redness, swelling and congestion, at first with a thin, watery discharge, which later becomes thick and finally purulent with a fetid odor. At times mucous patches appear within the vestibule. The tertiary lesions are superficial or deep ulcerations or granulomata. These lesions first appear as a purplish or reddish swelling, subsequently softening; if large enough, this swelling will cause obstruction and neuralgic pains. The superficial ulcers have sharply defined edges with no congested areolæ and with their centers covered with muco-pus, while the deep ulcers are the result of broken-down gummata and tissue necrosis, producing an offensive odor which once recognized will never be forgotten. The necrosis is followed by contracting scar-tissue, the resulting disfigurement depending upon the location of the destroyed tissue, and if the lesion has involved the nasal bones or cartilaginous septum and has not been promptly arrested with treatment, the nose will afterward become flattened. The syphilitic granulomata are very chronic and as a rule do not break down or cause destruction of the tissue.

Diagnosis.—The aid of the bacteriologist should be sought for detecting the presence of the spirochæta pallida in both primary and secondary lesions of the patient. Clinically, the tertiary lesions are the easiest to diagnose, but as syphilis may closely resemble both tuberculosis and malignancy, a Wassermann test should be made and a section of tissue submitted to the pathologist for examination, as both tuberculosis and malignant growths may show some improvement under mercurial treatment, and thereby valuable time be lost.

Treatment.—Administration of salvarsan or mercury, preferably by injections, is most strongly advised. Only non-irritating sprays or douches of normal saline solution or of oils should be used locally for the primary and secondary lesions. The necrotic portion should be removed in the tertiary lesions and the ulceration made as healthy as possible with astringents, such as silver nitrate, 50 per cent. solution, or liquor hydrargyri nitratis, 25 per cent. to 50 per cent. solution, the latter being more painful.

Congenital Nasal Syphilis.—In infancy, syphilis is quite characteristic on account of the shriveled infant with the "snuffles," and with a coryza which is apt to be more severe than it is in adults and cause much distress while the child is feeding and breathing. Fissures about the nares are common, followed by the flattened nose, due more to mal-

development than to necrosis; otherwise the nasal symptoms are similar to those of the acquired form.

Glanders (*rare*).—This is a contagious disease in horses which is rarely transmitted to man, but when it is, the primary lesion is frequently located in the nose. Constitutional symptoms are severe in acute cases, the patient rapidly assuming the typhoid state with small submucous granular tumors forming in the nose, which tumors rapidly ulcerate, giving rise to a very offensive discharge, with a swelling of the nasal mucous membrane, which is not usually painful, and with necrosis of the bone and cartilage ensuing and adenitis developing.

Diagnosis.—The diagnosis can be definitely made by identifying the bacillus mallei in stained smears of the discharge, or by animal inoculation. The last stages of the disease may closely resemble typhoid fever or pyæmia.

Treatment.—Open the abscesses, and then use douches of potassium permanganate solution.

Leprosy (*rare*).—This disease is observed for the most part in the foreign born, and is very slightly infectious to the native American. This disease is caused by an infection from the bacillus lepræ. The mode of the infection is still unknown. The nasal lesions are part of the general disease, and are of the anæsthetic and nodular types. In the case of the latter type, the mucous membrane first becomes red, then thickens, becoming lighter in color, at which time the nodules appear in the submucous strata and are composed of granulation tissue which eventually breaks down, forming ulcers from the size of a nodule to the destruction of bone and cartilage.

Diagnosis.—Diagnosis is usually made very easily from the lesions on the skin, although these lesions sometimes closely resemble tertiary syphilis, which doubt can be ruled out by mercurial administration. A positive diagnosis of the condition can be made by identifying the leprosy bacillus in the nodules or in the discharge from the ulcerated lesions. A Wassermann test is of little value, as it usually gives a positive reaction in leprosy.

Prognosis.—The disease is usually fatal, but there are a few reported cures.

Treatment.—Chaulmugra oil is recommended, using as many as 60 drops daily.

Actinomycosis.—This infection is only mentioned as a possibility.

Scleroma.—Scleroma of the nasal passages is caused by the bacillus of Frisch (Friedlander). The characteristic microscopical elements in

the granuloma are the bacillus, "foam cells," hyaline bodies, and round-cell infiltration. The nodules first appear in the neighborhood of the orifice or nasal vestibule, then extend outward upon the upper lip, sometimes upon the face, and occasionally backward into the nasopharynx and larynx. They are red, soft, and at first sharply defined, then they become paler in color, hard, and diffuse with scar tissue and contraction, resulting in repeated epistaxis and occlusion of the nose, the surface becoming slightly eroded, with crust formation and a characteristic garlic-like odor.

Diagnosis.—Diagnosis is not always easy. The involvement of the pharynx and larynx affords some aid, and clinically the hard, rigid and non-ulcerating granuloma is suggestive, and the Frisch bacillus, foam cells and hyaline bodies observed microscopically in the excised tissue, and a pure culture of the bacilli obtained from the blood of the lesion, will confirm the diagnosis.

Treatment.—Drugs are of little value. Surgery is indicated in so far as it may relieve the nasal obstruction. The X-ray gives the best results, but unfortunately it does not reach the lesions deep within the nose, while vaccines give varying results.

TUMORS, BENIGN

Nasal Polyp.—Benign nasal polyp is the most frequent growth within the nasal cavity, and is a low grade of connective-tissue tumor, often confused with a polypoid degeneration of the mucosa from purulent inflammation. Many theories regarding their causes have been advanced. Personally, I believe that they are due to some infective process of the mucosa, existing or having existed, especially in the ethmoidal cells or other accessory sinuses. In color and consistency they closely resemble a raw oyster, usually with a smooth surface and attached by a pedicle. They vary in size from a pea to a mass entirely filling the nasal cavity, and may protrude from the anterior nares or back into the nasopharynx, causing complete occlusion and at times spreading the nose from pressure until the face has a frog-like expression. The polypi may be attached to any part of the nasal mucosa. Sometimes they are firm, with a thick white surface over which blood-vessels are seen coursing. Generally they are composed of a network of areolar tissue, the meshes of which are filled with serum, fibrin, and mucoid material, with fibrous stroma present, and covered with a ciliated, columnar epithelium.

Symptoms.—The symptoms depend upon the size and the situation of the polypi. If they are found about the ethmoidal region, anosmia and reflex symptoms, such as asthma and cough, may exist. There is increased secretion, but it is not purulent or offensive unless some of the sinuses are much involved. Occlusion of the nasal passages produces change of voice and mouth breathing. Pain and headache are rarely present.

Diagnosis.—Diagnosis is easy, but it is well to have a microscopical examination in all cases of prompt recurrence after the removal of the polypi, also when the tumor is a mixed one, and when it is of a firm consistency.

Treatment.—Remove with a snare or, better, seize them with a dull forceps and suddenly jerk them out. When they are attached to the septum or nasal floor, which is rare, nothing more is needed, but when attached to the upper part of the nose, the associated sinus disease must be cured to prevent recurrence.

Papilloma.—Fibropapillomata are rare. They usually spring from the inferior turbinate or septum. Microscopically, they exhibit hypertrophy of all the normal elements of the papillæ. They are small, resembling a cutaneous wart, and rarely cause symptoms.

Treatment.—Remove the tumors, cauterizing their bases.

Angioma or Bleeding Polyp of the Septum.—These growths, occurring on the anterior part of the septum, are small, nodular, and sessile. They are composed of blood-vessels or blood-channels in a connective-tissue stroma with a covering of columnar epithelium.

Symptoms.—The most prominent symptom is recurrent epistaxis and, if the tumors are large enough, nasal obstruction.

Diagnosis.—The diagnosis is fairly easy when the growth is situated upon the anterior part of the septum, with a granular surface, soft in consistency, red or purplish in color, occasionally being seen to pulsate and having a great tendency to bleed. Microscopical examination should be made to determine the nature of the growth.

Treatment.—Snare off very slowly, cauterizing the base.

Chondroma.—This type of tumor is exceedingly rare. It develops from the cartilage of the septum, and is of slow growth. The symptoms are purely mechanical, and when the growth is of sufficient size to obstruct the nose, it should be removed.

Fibroma.—This tumor is rare, usually situated on the middle or inferior turbinate, its pathology being the same as that of fibrous tumors elsewhere with mechanical symptoms, except that the erosion

of its adjacent membrane causes hemorrhage. It is firm to the touch, and may be large enough to cause a frog-face expression.

Treatment.—Remove with snare or forceps, and pack to control hemorrhage.

Osteoma.—This type of tumor may be cancellous or eburnated, and usually originates in the upper part of the nose or accessory sinuses. The pedicle may disappear and show no signs of the attachment and removal.

Symptoms.—These are mechanical, and if of sufficient size, the growth may cause deformity, invading the orbit. I have seen one larger than a hen's egg without bony attachment, requiring the removal of the anterior antral wall, part of the nasal bone, and part of the orbital wall for its delivery.

Mucocele.—This type has the appearance of a polyp with a broad base, and is in reality a retention cyst, containing a fluid in which are found albumin and mucin.

Symptoms.—Similar to those of nasal polypi.

Treatment.—Open and apply caustic, such as silver nitrate, to the walls.

Teratoma.—This is a very rare congenital tumor which appears in the nose, showing a variety of embryonic tissue.

Hemangioma and Lymphangioma.—These growths are composed of dilated capillaries of either kind. They are generally multiple, and have a great tendency to bleed.

Cysts.—Cysts may occur in the nose as elsewhere in the body. They present no especial feature characteristic of the locality.

TUMORS, MALIGNANT

Sarcoma.—Sarcoma, which is rare, may arise from any part of the nasal cavity, and may be concealed by polypoid tissue. The histological structure and varieties are the same as in the other parts of the body, the small, round-cell variety growing rapidly, while the large-cell variety is more common and of slower growth, being usually nodular and of a soft consistency.

Symptoms.—The first symptoms are obstruction and pain, the latter depending upon the pressure, then hemorrhage from ulceration, with offensive discharge.

Diagnosis.—Diagnosis should be confirmed, microscopically. Remove a fair-sized specimen which includes the deeper structures;

otherwise the microscopical findings are apt to be misleading, as the sarcomatous tissue may be overlaid with polypoid tissue.

Prognosis.—The prognosis depends upon the rapidity of the growth, the size of the tumor when discovered, and the thoroughness with which it is removed.

Treatment.—Do not dally with curetting or cauterizing, but by a radical external operation, remove the entire growth with a wide margin of the healthy tissue.

Carcinoma.—Carcinoma, which is rare, may be squamous or glandular. The squamous form, or epithelioma, has pain as its prominent symptom, the growth at first being a nodular infiltration, which breaks down early into a deep, ragged, ulcerating cavity, accompanied by a foul discharge with hemorrhage from time to time; then cachexia ensues.

Diagnosis.—A hard, nodular, infiltrating growth, with a deep, ulcerating center is strongly suggestive of carcinoma, but syphilis may give the same clinical picture; therefore, a microscopical examination should be made. For this purpose, if possible, procure a large section, including a portion both of the growth and the adjacent normal tissue, avoiding, as far as possible, the ulcerated area, as that often shows nothing more than inflammatory tissue.

Prognosis.—Prognosis is bad except in very early cases, when radical and immediate removal, including much normal surrounding tissue, may cure, or at least prolong the patient's life.

Treatment.—When discovered in the early stage without glandular involvement or much infiltration, radical removal is indicated. When the growth has acquired some size, it is better to use palliative treatment.

Adenocarcinoma or Malignant Adenoma.—The glandular carcinoma has a clinical appearance very different from epithelioma, being a soft proliferating growth, the surface of which is red or purplish, and is not apt to ulcerate, and sometimes bleeds. I have seen three cases, all of which originated in the accessory sinuses, one case having metastases, their post-operative course showing them to be much less malignant than squamous carcinoma.

Treatment.—Radical removal even when of considerable size, with as much of the adjacent gland-bearing tissue as possible.

NASOPHARYNX

Injuries.—Trauma of the nasopharynx is rare. I have never seen one due to accident. Occasionally cases are observed in which some

crude operation has injured the prominence of the Eustachian tubes or the operator has removed some mucous membrane, resulting in an atresia of the nasopharynx. Deformity and atresia of the nasopharynx are usually caused by syphilis. The relief of the constricting band of adhesions is a difficult matter. Several methods have been proposed, but the ultimate benefit derived from these may be very slight, as there is a great tendency to fibrous reconstruction. This undoes most of the work, especially where the posterior surface of the velum is adherent to the post-pharyngeal wall which is the usual deformity. Some method must be used which will provide epithelium to cover one surface of the velum when it is freed. Flaps of mucous membrane from the cheeks can be brought back and fastened so as to cover one surface and thereby keep them apart while healing.

Infections.—*Tuberculosis.*—So-called latent tuberculosis may exist. This is not appreciable clinically, but is detected microscopically. Tuberculosis also occurs as a late ulcerative process, secondary to pulmonary involvement. Both are rare, the latent being the more frequent of the two.

Lupus.—This may involve the nasopharynx, but it is an extremely rare condition.

Syphilis.—Both congenital and acquired syphilis may attack the nasopharynx, and the picture will be found to be similar to that of the nose. Resulting contractions, after tertiary lesions, are characteristic.

Glanders.—This condition may extend from the nose to the pharynx.

Hyperkeratosis.—This is a condition manifested by pearly white, small tufts on the mucous membrane, usually on lymphoid tissue, and may sometimes be seen in the nasopharynx. It is usually an extension from the pharynx. Its etiology is very obscure. Pathologically, the tufts are horny-like growth of epithelial cells which have lost their nuclei. This condition rarely gives symptoms, but sometimes patients complain of a sensation of dryness and stiffness of the throat.

Treatment.—Usually no treatment is necessary as the lesion causes no harm. The galvano-cautery into each tuft will destroy it.

Pharyngeal Tonsil or Adenoid.—The pharyngeal tonsil or adenoid, springing from the vault of the nasopharynx, is composed of lymphatic tissue, which is highly vascular, and a normal structure that should atrophy between twleve and fourteen years of age.

The adenoid should receive surgical attention whenever its resistance has been overcome by septic bacteria and there is an enlargement of the chain of the lymphatic glands into which it drains. These

glands run from the tip of the mastoid, downward and backward, and are palpable only when enlarged, at which time they range in size from that of a French pea to that of an almond. Adenoids may cause nasal catarrh, sinus infection, Eustachian tube catarrh, otitis media (catarrhal or purulent). Long-continued obstruction prevents development of the facial bones causing narrow nasal passages and permanently impairing nasal breathing, obliging the patient to breathe through the mouth continuously, usually leading to deformed chest walls, "chicken breast," also often producing a high arch of the hard palate and a deformed dental arch. The child appears tired, under-weight, and bad tempered, while the open mouth gives a dull facial expression, frequently combined with a concomitant deafness, which gives the child the appearance of being stupid. The obstructed nose causes spasmodic cough, asthma, snoring, restlessness at night, bad dreams, recurrent coryzas, and change of voice. The direct connection of the pharyngeal lymphatics with the brain and pituitary gland often produces real mental dullness which tends to disappear after the removal of the adenoids. All of these symptoms are not necessarily present in every case.

Diagnosis.—The adenoid should be inspected with a rhinoscopic mirror. However, when this cannot be done, diagnosis can be made by the sense of touch, giving a better idea of the extent of the hypertrophy. Using great care not to injure nor to frighten the little patient, with your left arm and hand place the child's head firmly against your left side, instructing the patient to open the mouth. Pressing the cheek inward between the teeth with your left index-finger, to prevent the patient from biting, now pass the index-finger of the right hand over the tongue, depressing it as much as possible, until the finger reaches the post-pharyngeal wall; rapidly pass the end of the finger upward into the nasopharynx, sweeping it from side to side to determine the size of the adenoid; quickly withdraw the finger, keeping away from the hard and soft palate to prevent the tendency to retching and contraction of the velum. In a very young child, whose nasopharynx would be injured if the finger were introduced, the diagnosis can be made by placing a stethoscope behind the angle of the jaw, where a roaring sound, accompanied by many moist râles will be heard. Obstructed nasal breathing, inability in infants to nurse without stopping to breathe, restless sleep, and ear complications tend to confirm the diagnosis.

Prognosis.—The prognosis is good when the adenoid is discovered and removed early, but not so good when the hypertrophy has been of

long standing and the bones of the face have been retarded in development or when there are changes in the ears.

Treatment (Figs. 141 and 142).—There is only one successful treatment and that is total removal. It is best to give ether, as without an anæsthetic or under local anæsthesia, the chances are in favor of some of the lymphoid tissues being overlooked, leaving a source for further hypertrophy and trouble. The methods and instruments for this operation are legion. The Gottstein curette and one of the many adenoid forceps are all that are needed, the Brandegee forceps being probably the

Fig. 141.—Adenoid curette.

best all-round instrument. By the sense of touch, using the index-finger, the size of the growth and the contour of the nasopharynx are determined; then using a curette fitting the particular case, endeavor to remove the entire adenoid with one sweep of the instrument. I have six different sizes of curettes, of which I introduce the one best suited to the case, passing it upward behind the velum until it comes into contact with the posterior border of the nasal septum, then gently but firmly pressing the curette backward until it engages the growth, keeping the curette in firm contact with the superior and posterior wall of the

Fig. 142.—Adenoid forceps. (*Brandegee.*)

nasopharynx, and then passing it backward and downward, having the handle always in the median line. This procedure will usually remove the entire adenoid with the least trauma. If the contour of the nasopharyngeal space is such that the curette cannot engage all of the growth, by using the index-finger, the remnants can be felt and then engaged with the adenoid forceps; placing the index-finger behind the forceps while withdrawing them will prevent the post-pharyngeal wall from being stripped. A brisk primary hemorrhage will follow which can be checked to a large extent by applying towels saturated with ice water

to the face. There is rarely a secondary hemorrhage, but if there should be one, it can be checked by a post-nasal tampon.

Tornwaldt's Disease.—This is a purulent infection of the bursa of Luschka, characterized by a purulent discharge and crusts on the posterior nasopharyngeal wall or near the vault. The discharge usually dries into a crust. The secondary symptoms are catarrh in the Eustachian tubes and cough.

Treatment.—Removal of the pyogenic sac with the adenoid forceps.

TUMORS

Fibroma of the Nasopharynx.—This is usually composed entirely of fibrous, sometimes mixed with sarcomatous or myxomatous tissues. It is a rare, but very serious condition, developing early in youth, more often in males, and originating from the basillar process of the occipital bone, with a tendency toward retrogression after the twentieth year. The symptoms, depending upon which way the growth extends, may be nasal obstruction, hemorrhage from pressure, change of features, frog-face, and when the growth extends downward, its pressure causes constant desire to swallow. A change of voice from the obstruction and mouth breathing may result, while extension into the cranial cavity causes headaches, etc.

Diagnosis.—A growth in the nasopharynx that is hard, grayish or pinkish in color, which may be nodular or smooth with any exposed surface in the throat or with the anterior nares rough like a hard papilloma, especially in young males, is fairly conclusive.

Prognosis.—The prognosis depends largely upon its size. While small, with a few adhesions and extensions, the outlook is favorable, but if it has extended into the nose, accessory sinuses or the brain, it becomes a vitally serious condition.

Treatment.—Some attempts have been made to reduce the growth by injecting acids. These are not satisfactory, and the resulting slough may lead to serious hemorrhage. Removal by the natural passages if possible, is the most satisfactory method. Be prepared for a most profuse hemorrhage at the time of its removal. A pedunculated fibroma can be snared off, but it is a waste of time to try to use the snare on a broad attachment. The sessile variety can be best removed by evulsion under general anæsthesia, being mindful of the severe hemorrhage that may ensue. Pass tapes through both nares, tying gauze tampons to the mouth end, using the tapes also for tying the velum

forward out of the way. The growth is then seized with a powerful forceps (Stucky's) which is modelled after Brandigee's adenoid forceps, but is much stronger, and the growth being wrenched from side to side and forward, the finger of the other hand being used as a blunt dissector, is delivered through the mouth. A severe flow of blood follows the detachment of the fibroma, and is promptly controlled with the tampons that have been in readiness on the tapes previously passed through the nose. The tampons should be carefully removed after 48 hours.

Adenoma, chondroma, lipoma, and papilloma are very rare.

Fibromyxoma is rare, but more frequent than fibroma, and usually springs from the posterior part of the nose, growing downward into the nasopharynx. This condition differs from myxoma of the nose in that it contains more fibrous tissue, and consequently is firmer to the touch, and like all benign growths, it gives symptoms of occlusion, according to its size.

Treatment.—Treatment consists of removal with the snare.

Sarcoma.—Sarcoma is very rare, springing from the basillar process of the occipital bone and is usually of the small round-cell variety. It is of soft consistency and of rapid growth, extending to the adjacent structures, generally downward and often produces a bloody discharge with an offensive odor.

Treatment.—This condition is usually inoperable.

Carcinoma.—Carcinoma is also very rare and of slow growth with obstruction and pain as the growth extends, and accompanied by a foul discharge. These cases are generally inoperable.

DISEASES OF THE ACCESSORY SINUSES

General Considerations which Apply to all Sinuses.—The normal sinuses are practically sterile, though microörganisms can and do enter, rapidly disappearing, however, partly because of the action of the ciliated epithelium and partly because of the fact that the secretion of the sinus mucosa inhibits bacterial growth.

Why then do the sinuses become infected?

Usually there is some anatomical abnormality, such as a deviated septum or a large middle turbinate, or an acquired abnormality, such as hypertrophy or hyperplasia of the mucosa, which closes off the ostia of one or more of the sinuses at the time of slight inflammatory swelling, creating a closed cavity, and the direct extension of this inflammation producing proper soil for a purulent process in the susceptible individual.

Extension by the blood and lymph channels may occur, but this is extremely rare. Some of the predisposing causes are exposure to cold, automobiling, cold baths, foreign bodies, etc. Sinus infections are frequent complications of epidemic influenza, pneumonia, measles, scarlet fever, tuberculosis, syphilis, typhoid fever, cerebro-spinal meningitis, diphtheria, and erysipelas. The most frequent immediate causes are recurrent infective inflammation of the nose (coryzas), influenza and pneumonic infections, and in about 35 per cent. the antrum is infected from diseased teeth. The usual infecting organisms are streptococci, staphylococci, pneumococci, influenza bacilli, and other pyogenic germs. In acute cases the infection may be pure, but in all chronic cases the infection is most decidedly mixed.

Trauma may cause infective inflammation in the frontal sinus or the antrum, but is extremely rare.

Pathology.—In acute conditions the mucosa shows changes similar to those of any infected mucosa, viz., lymph in the intercellular spaces and a varying amount of polynuclear and round-cell infiltration, while chronic cases show polypoid degeneration, increase of fibrous tissue, and round-cell infiltration.

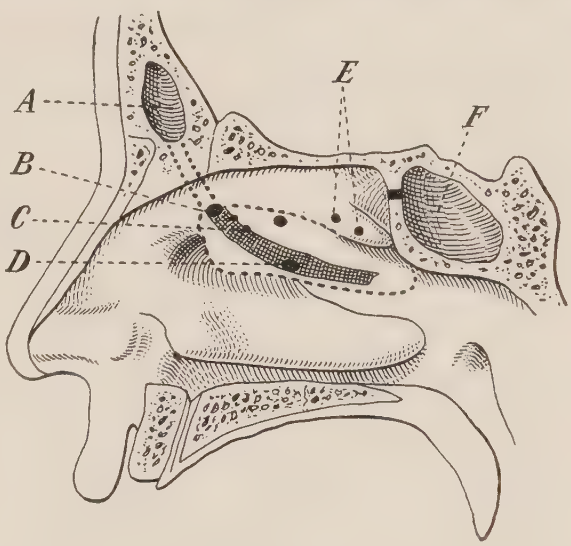

FIG. 143.—Lateral wall of the nasal cavity. *A*, Frontal sinus; *B*, orifice of the frontal duct; *C*, hiatus semilunaris; *D*, ostium of the antrum; *E*, orifices of the ethmoidal cells; *F*, sphenoidal cell. The removed middle turbinate is outlined by dotted line.

To clearly understand why the orifices of the sinuses are easily occluded some knowledge of the anatomy of the external nasal wall is necessary (Fig. 143). From the nasal floor upward to the attachment of the inferior turbinate is a thin plate of bone which is important because through this bony wall the needle punctures and the intranasal operation for antral disease are done. The most important region is situated above the inferior turbinate, viz., the hiatus semilunaris, which might be termed a curved gutter, convexity downward, extending from a point external to the anterior attachment of the middle turbinate backward to about half the length of the middle turbinate. A cross-section of the hiatus is usually pear-shaped, the deeper portion being termed the infundibulum, the lower boundary the uncinate process, and the upper, the ethmoidal bulla, internally, the middle turbinate hanging like a curtain; consequently, when the turbinate is

hypertrophied or crowded over against the opening of the hiatus by a septal deviation, the drainage of the latter can be easily impeded by an inflammatory swelling.

The orifice of the frontal duct opens at the anterior end of the hiatus and all of the anterior ethmoidal cells drain into it, while the antral orifice is at the posterior end; therefore, the pus appearing under the middle turbinate must come from the frontal sinus, anterior ethmoidal cells or from the antrum.

Above the hiatus is found the ethmoidal labyrinth, roughly a parallelogram, bounded below by the hiatus and the middle turbinate, externally, by the orbit, superiorly, by the anterior cranial fossa, and internally, by the olfactory fissure, the latter leading to the cribriform plate. The posterior ethmoidal cells have their orifices above the middle turbinate in one or two furrows on the inner wall of the labyrinth.

The sphenoidal sinuses occupy the body of the sphenoidal bone, with frequent extensions into the greater and lesser wings, the orifice being near the roof of the sinus and opening through the anterior wall of the sphenoidal bone into the sphenoidal fissure.

Symptoms.—The most frequent symptom is pus or muco-pus, discharging anteriorly or posteriorly from the nose, though lack of history of secretion or absence of pus in the nose do not necessarily rule out sinus disease.

Anosmia and cacosmia are strongly suggestive of sinus involvement. The blocking up of the olfactory fissure with swollen mucosa and the toxic effects of the pus on the olfactory filaments, regularly lead to loss of smell, while stale pus, infected with saprophytic organisms, produces an offensive odor which is exceedingly disagreeable to the patient if he has retained his sense of smell and to his acquaintances.

Headache.—There may or may not be local or general headache, though usually it is a symptom in acute cases, and its constant presence which is due to pressure, to irritation of the mucosa, to ulcerations or to toxins in chronic cases is to be considered a grave symptom. Some practitioners consider certain locations of the headache as indicative of a sinus being involved, but I deem it as quite an unreliable sign, as irritation of any branch of the trigeminal nerve may produce pain or headache in some other branch. For instance, antral disease may produce frontal headache or pains in the upper or lower teeth and ethmoidal disease may produce headache or pain over the frontal sinus.

Neuralgia may be caused by involvement of one of the sinuses. Headache and neuralgia are so often symptoms of sinus disease that in all cases the sinuses should be carefully examined. Stooping, any sudden jar, jumping, or any movement tending to a sudden increase of intracranial pressure usually aggravate the headache and neuralgia.

Tenderness in frontal sinusitis is usually present on the anterior and inferior walls, and in antral infections over its anterior wall. Tenderness may also be elicited on the anterior sphenoidal wall by means of a probe, passed through the nose after cocainization when the sphenoid is involved. In acute cases tenderness is usually present and frequently in chronic cases, especially about the frontal sinus. Percussion of the anterior frontal wall often produces pain over the limits of the affected sinus. Dizziness and sometimes vertigo are observed in some cases of frontal and ethmoidal disease.

General Symptoms.—The general symptoms are similar to those of a localized septic process in any other cavity with osseous walls, and if there is an outlet for the secretion, there will be but a slight rise of temperature and pulse, but if the ostium is occluded, a rather stormy time ensues with increase of temperature and pulse. Occasionally, in chronic cases of long standing, there is a toxic tachycardia which continues for months after the sinuses are well. The secretion may produce chronic laryngitis and bronchitis with cough, also general symptoms, which may be associated with any other chronic septic process in the body, such as gastric disturbances, constipation, neurasthenia, mental dullness, melancholia, etc.

Diagnosis.—The detection and location of an infected sinus or sinuses are at times tedious and difficult.

Locating the Source of the Secretion.—In acute cases the nasal mucosa may be greatly congested and swollen. In such cases the first step is to reduce this condition with cocaine, 1 per cent. solution, and suprarenal solution, 1/10,000; then thoroughly cleanse the nose and look for a discharge, which if it shows beneath the middle turbinate is from the frontal sinus, antrum or anterior ethmoidal cells, if between the middle turbinate and septum, it comes from the posterior ethmoidal cells or sphenoidal sinuses, but if secretion seems absent, its presence may be made obvious by means of the use of the suction apparatus (Fig. 144). The anterior nares are closed with the tips of the suction tubes, and the patient requested to say "K," which will close the posterior nares, and the suction may produce the secretion,

especially from the frontal, ethmoidal cells or sphenoidal sinuses. This secretion, as it becomes visible, is engaged in a small silver cannula, the secretion stringing out toward the sinus from which it comes. This procedure is not quite so reliable and easy in the case of the antrum on account of the situation of its ostium.

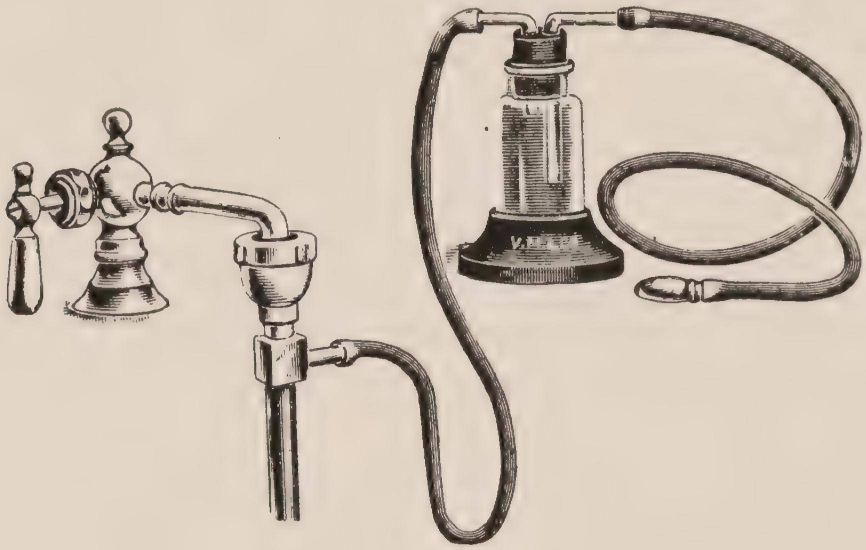

FIG. 144.—Brawley's suction apparatus.

The nasopharyngoscope of Holmes (Fig. 145) is of great value in detecting secretion from the sphenoidal sinus and posterior ethmoidal cells. Passing the instrument along the floor of the nose, directing the light upward; as it passes backward, strings of pus can be plainly seen coming from the sinuses. Now by passing the instrument beyond the posterior border of the septum, the opposite side can be inspected for a short distance, and if the middle turbinate has been removed or

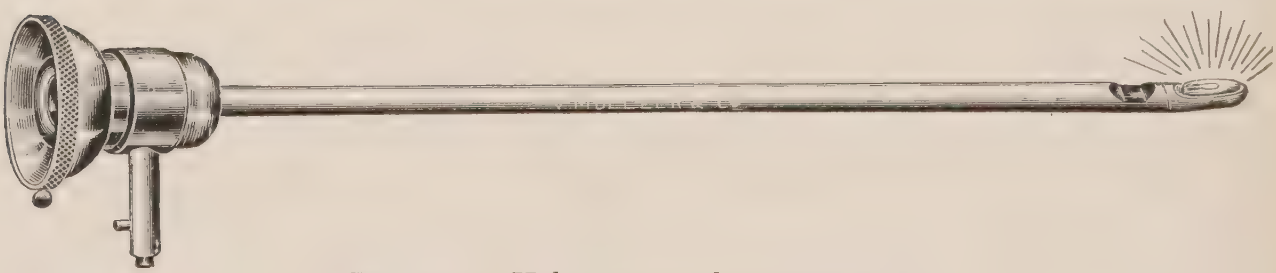

FIG. 145.—Holmes naso-pharynogoscope.

is atrophied, the ostia of the antrum, the anterior ethmoidal cells and frontal sinuses may be inspected, proving the great aid and value of this instrument.

The cannula and douche, as a means for detecting secretion, are not so easily used, as the orifices of the anterior sinuses are covered by the middle turbinate, and frequently a septal deviation prevents reaching the sphenoidal sinus. Infracting the middle turbinate will usually give access to the frontal sinus and antrum, but more positive results can be

gained in the antrum by needle puncture of the nasoantral wall, the bone being thin under the inferior turbinate. The field having been anæsthetized, a curved needle is passed under the inferior turbinate, about half an inch from the anterior attachment, and with a quick twist of the wrist it is passed through the antral wall; if it does not readily enter, tap it lightly with a mallet, using great care not to enter the orbit by passing the needle too far, and also not to drive fluid into it under too great a pressure. Now douche gently and if resistance is encountered, proceed very slowly and carefully, using plenty of fluid, as the secretion may be thick, and the first flow, therefore, show no results. Changing the tip of the needle a trifle may improve the flow, resistance to the return flow meaning a thickened or polypoid membrane. The finding of pus in the antrum does not necessarily imply that the antrum is diseased as it may at times be merely the reservoir for frontal or ethmoidal pus.

To douche the frontal sinus the middle turbinate must be infracted or removed in all but a small per cent. of cases. A small silver cannula, bent at nearly a right angle and measuring ¾ in. from the bend to the tip, can be introduced into the frontal sinus. In order to be sure that the cannula is in the sinus and not in an anterior cell, the shaft should lie easily upon the upper lip and parallel to it, and the tip will rotate to some extent within the sinus. If the frontal sinus and anterior ethmoidal cells are infected as well as the antrum, the upper sinuses should be drained first in order to make sure that the antrum is not a reservoir. If the cannula can be passed through the olfactory fissure to the anterior sphenoidal wall, the sphenoidal orifice may be entered by slight rotation outward, or if the middle turbinate has been removed, the orifice can be entered under inspection.

The Röntgen ray (Fig. 146) is a most valuable aid, and should be used in every case where there is doubt and where operative procedure is contemplated, though the findings should not be considered as absolute. Only an expert can make a satisfactory X-ray plate and considerable training is necessary for the surgeon to interpret the plate which will show the size, height, depth, recesses, and septa within the sinuses, and to a certain degree, the condition of the membrane and its contents. Antero-posterior and lateral plates should be made.

Transillumination (Fig. 147) should be a routine office procedure in examining every nasal case, as it may show conditions which might otherwise be overlooked, and if on transillumination, done by placing the hooded lamp on the floor of the sinus, above the inner angle of the

eye, one side of the frontal sinus is dark when compared with the other, more extended examination of the sinus is suggested, the same holding true of the antra. If the exposed lamp, placed in the mouth, shows less glow on one side, especially just under the eye, attention is drawn

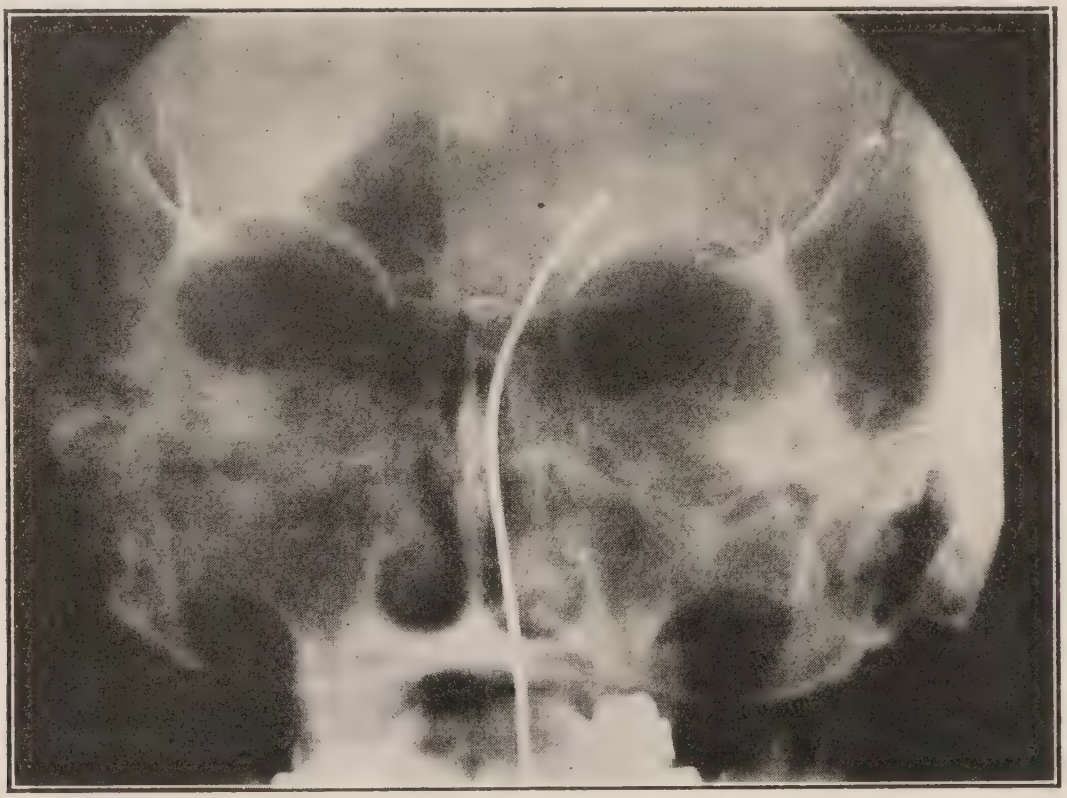

FIG. 146.—X-ray of the nasal accessory sinuses, showing disease in the left frontal and ethmoidal cells. The probe is in the frontal sinus.

to that antrum, this method being, however, unreliable, both because the accessory sinuses vary in size, and also because of the thickness of the walls.

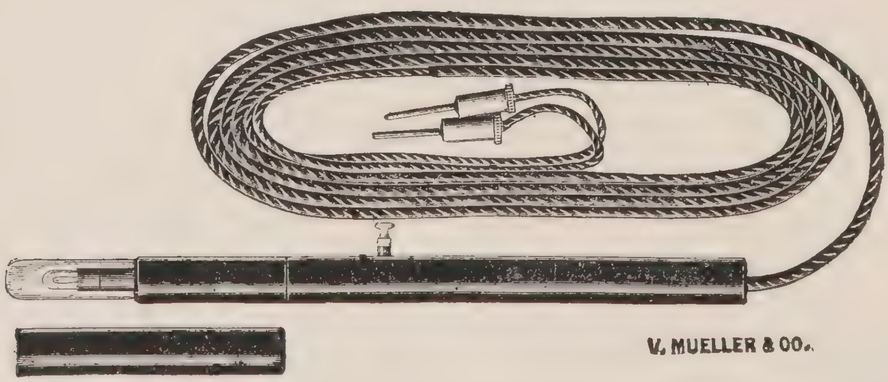

FIG. 147.—Haden's transilluminating lamps.

Prognosis.—Nearly all acute cases recover, while chronic cases are probably never cured without operative procedure, not however proving fatal, although some of the complications may readily terminate fatally.

Complications.—The complications are œdema of the lids, fistulæ, conjunctivitis, lesions of the cornea and retina, loss of accommodation,

contracted color fields, orbital abscess, muscular immobility, thrombosis of the central vein of the retina, cavernous sinus thrombosis, optic neuritis which may be toxic or from pressure, meningitis, brain abscess and the sinus focus, which is the cause frequently overlooked.

Treatment.—It is understood that there are all cases, acute and chronic, ranging from quite mild to extremely severe; the treatment, therefore, has to meet varying conditions. As here outlined, it is for the average well-marked case, acute cases, showing a strong tendency toward spontaneous recovery, recurrent attacks, however, probably leading to chronicity. A nasal douche of normal saline solution, as warm as the patient can endure it (about 115°F.) every two hours, and thorough shrinking of the nasal mucosa with cocaine solution, 1 per cent., and adrenalin solution, 1/10,000, once or twice a day will greatly relieve the congestion and promote better drainage, while the leucodescent lamp or even on ordinary incandescent, 32-c.p. electric lamp, hung a short distance from the location of the pain, or hot compresses will be found to greatly alleviate the sufferings of the headache and neuralgia, in from 24 to 48 hours. But in chronic cases, the sinuses involved having been determined and treated, free drainage should be established as soon as possible, as medical treatment is of little value. It is a rare condition to have one sinus infected and the others normal, generally two or more being involved.

The ethmoidal cells, containing purulent secretion and degenerated polypoid membrane, are the most frequently involved, and may infect the frontal sinus, antrum, or sphenoidal sinus secondarily.

After anæsthetizing the nose, remove the middle turbinate, and then with biting forceps, remove as much of the ethmoidal labyrinth as can be seen. The anterior cells are harder to remove than the posterior, and their total removal is usually impossible through the nose; generally it takes several sessions to get out as much as necessary, as working in a bloody field is extremely dangerous, because of the proximity to the brain and orbit. Some of the operative complications are emphysema, hemorrhage into the orbit and eyelid, and from the ethmoidal vessels, and meningitis, all of which can be avoided with due care. The external indications and operation for exenteration of the ethmoidal labyrinth are quite similar to those of the frontal sinus.

The antrum is the next sinus in frequency of involvement, often relieved with quite conservative treatment, providing, however, that the frontal sinus or ethmoidal cells are not infected. Determine whether the infection comes from the nose or teeth. There is a great

liability to offensive odor in dental infection, while douching the antrum with cold water may localize a pain about the offending tooth. The

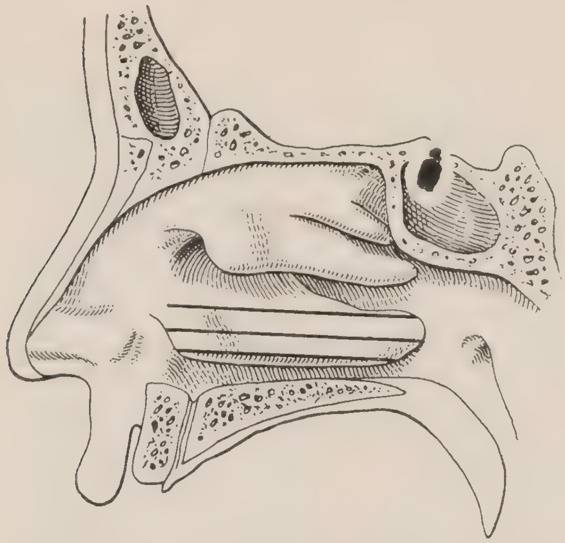

Fig. 148.—Line of the detachment of the inferior turbinate. The dotted vertical line shows the line of the fracture of the turbinate.

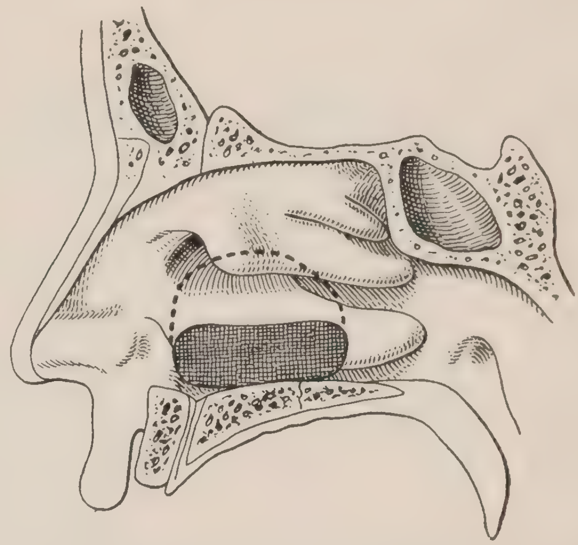

Fig. 149.—The dark areas illustrate amount of the naso-antral wall removed. Dotted lines are the limits of the antrum.

X-ray is the surest method of determining the condition of the roots of the teeth. If the infection is located in or about a tooth root, the re-

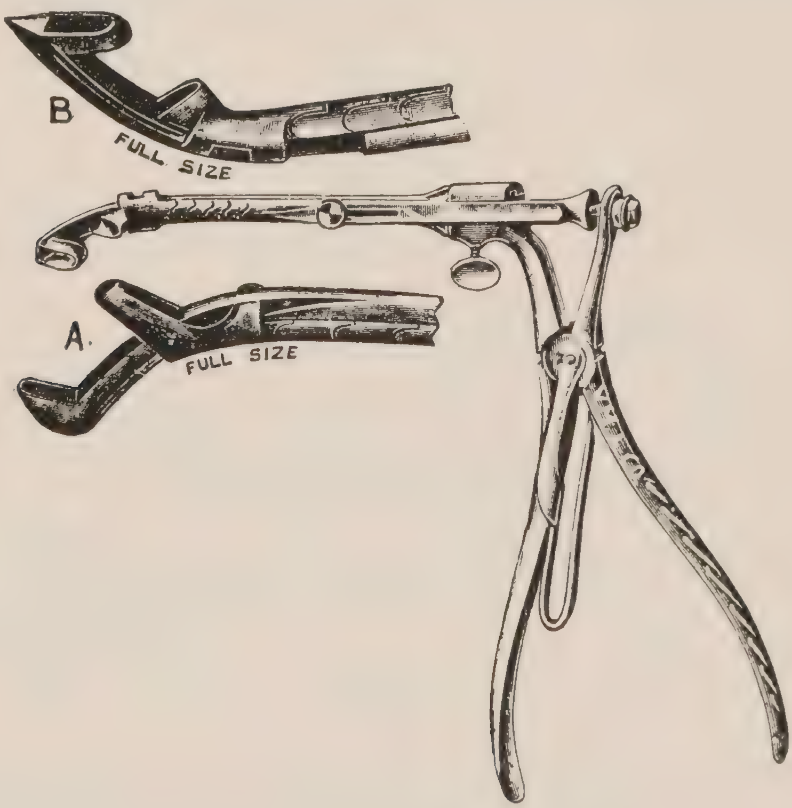

Fig. 150.—Wagner's antral forceps.

moval of the tooth is indicated. The conservative dental methods of opening the tooth root and treating it usually fail to cure the infec-

tion. After the removal of the tooth, a few douchings of the antrum will clear up the discharge. In a large per cent. of uncomplicated non-dental cases, daily douching of the antrum by means of the needle puncture (as outlined under diagnosis) will effect a cure. I have recently had some very brilliant results by filling the antrum daily with Beck's bismuth paste. (This treatment works equally well in the frontal and sphenoidal sinuses of both acute and chronic cases.) If improvement and a cure do not result in from six to eight weeks, the antrum should be drained into the nose under the inferior turbinate, for doing which the inferior turbinate is cut away from its attachment for about an inch with the scissors and then infracted over against the septum (Fig. 148). By needle puncture the anæsthetic is injected into the antrum. After waiting about 10 minutes, puncture the nasal antral wall with special chisel or forceps (Fig. 149), and remove all of the wall under the inferior turbinate with biting forceps, one pair of which should bite forward and another pair backward (Fig. 150). The inferior turbinate is then replaced, and held in position with packing for 24 hours. After the reaction of the operation, the patient can douche his own antrum, though it is rarely necessary, as in most cases the cure is spontaneous. A few cases, however, on account of anatomical variations or bone involvement, will not clear up, in such the antrum should be entered by the external route, by means of which an inspection of the whole interior of the cavity is possible.

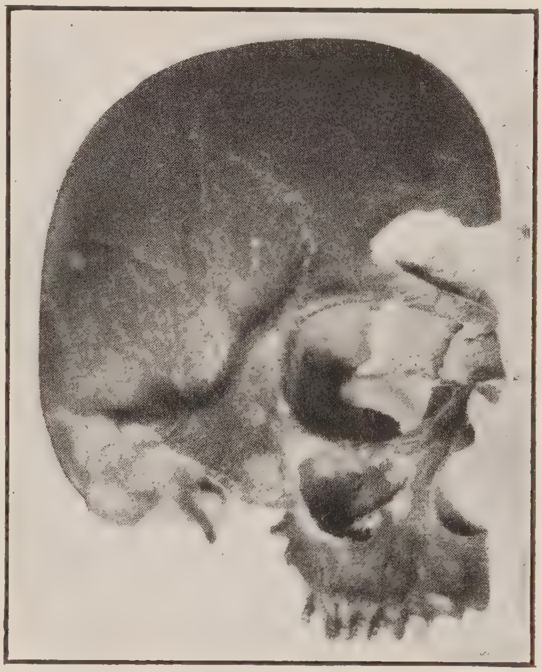

FIG. 151.—The skull with anterior antral wall removed as done in the external operation. It also shows the removal of the bone in the radical (Killian), frontal sinus and ethmoidal cell operation.

Technique.—Incise the mucous membrane in the gingivo-labial fold from the first molar to the second incisor tooth down to the bone of the canine fossa; elevate the periosteum to the brim of the orbit; enter the antrum with a curette at about the center of the fossa, and after the removal of all of the anterior bony wall (Fig. 151) the entire antral membrane can be inspected and removed, and the bony wall can also be examined. The bony nasal antral wall should be entirely removed without injury to the nasal mucosa, the inferior

turbinate bone being shelled out of its covering membrane, and a "T"-shaped incision be cut in the mucosa with the cross forward, making three flaps, one to be placed as a covering for the anterior edge of the nasal opening and the other two to be placed respectively on the roof and the floor of the antrum, being held in place with packing, the end of the gauze packing emerging from the anterior nares. The mouth wound should be allowed to close without sutures. The packing can be removed from the nose in 48 hours, at which time the flaps will have become adherent to the bone, the antrum now being merely an open recess of the nose where secretion cannot accumulate, and a cure should result.

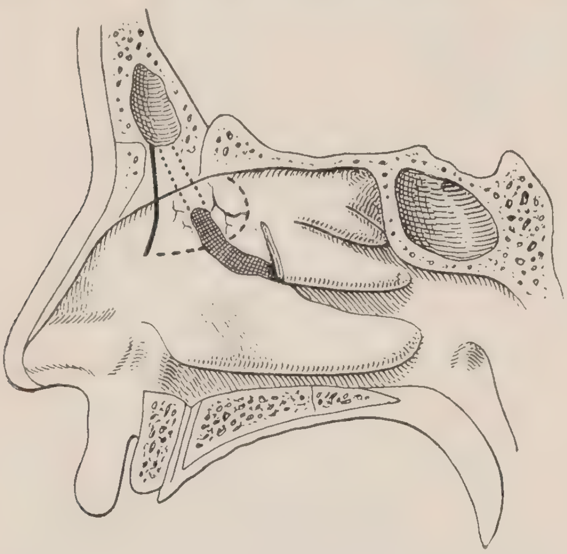

FIG. 152.—Anterior half of the middle turbinate has been removed and the anterior ethmoidal cells within the dotted line, including part of the frontal duct which should be removed for drainage of the frontal sinus.

Frontal Sinus Diseases.—About 93 per cent. of frontal sinus disease can be cured intranasally. After removing as much of the middle turbinate as necessary (Fig. 152) open the infected anterior ethmoidal cells which regularly accompany frontal disease, the uncinate process being chipped away with Myles' draw chisels (Fig. 153); also remove the small ethmoidal cells about the frontal duct, enlarging the duct by taking away a part of its anterior wall. The subsequent treatment consists of douching the sinus with normal saline solution or filling it with Beck's bismuth paste daily, which will promote better frontal drainage. In treating the frontal sinus, the ethmoidal cells should not be neglected, the sinus sometimes clearing up after the ethmoidal cells have been cured intranasally, but when the ethmoidals require the external operation, the procedure should also include the frontal sinus.

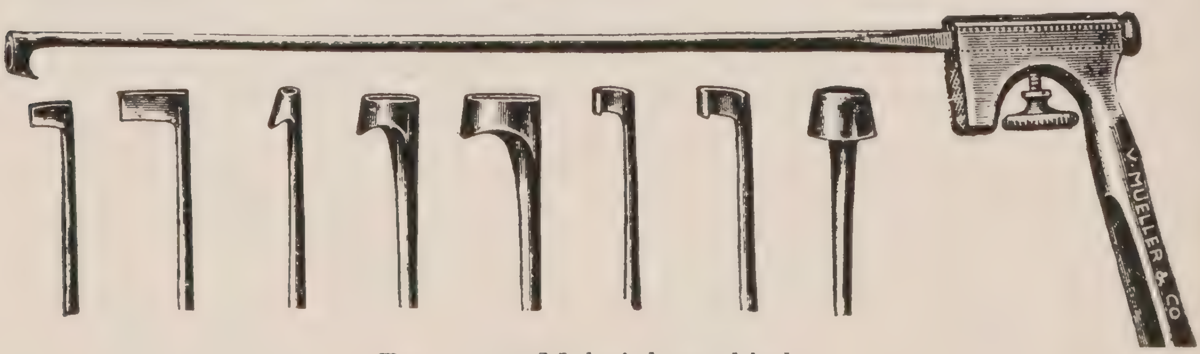

FIG. 153.—Myles' draw chisels.

Of the many methods devised for relieving frontal and ethmoidal diseases by an external route, Killian's has proven to be the best. Modifications of Killian's operation have been proposed from time to time, such as leaving the anterior frontal wall for cosmetic reasons, but this is poor practice. If the frontal sinus is small, there will not be a noticeable deformity, and if the sinus is large, it is impossible to be sure of removing all of the membrane from an opening in the floor of the sinus, the remaining portion causing sooner or later a sudden flare up with swelling, œdema of the eyelid, etc., distressing to both the patient and the surgeon. The resulting depression above the eyebrow, due to the removal of the anterior frontal wall, depending upon the height and depth of the sinus, is not so disfiguring as a poor result in the repair of the incision, cosmetic results depending largely upon perfect technical detail, while the depression can be filled in with paraffin if desired, although I have never been requested to use the paraffin. After-effect of the operation is an anæsthesia of the forehead, caused by dividing the supraorbital nerve, which in two or three months gradually passes away. Diplopia is often mentioned as an unfortunate sequela. This condition usually depends upon the treatment the trochlea receives. The trochlea can be safely detached from the bone with a sharp elevator, working from behind forward, with little likelihood of injury. Occasionally there may be transitory diplopia. It has been my observation that when a surgeon takes great care not to detach the trochlea, he has damaged it in endeavoring to obtain more space, at times resulting in double vision. Crust formation may develop as an intranasal after-effect soon disappearing except in atrophic noses.

Indications are difficult to define, the local symptoms, blood count, general symptoms, and the information revealed by the X-ray plates all need to be well considered. The external operation is rarely indicated in truly acute cases, and then only with an extension of the infection into the orbit or with a marked rise of temperature or with intracranail symptoms appearing. I do not consider pain or tenderness, no matter how severe, without a sharp rise of temperature, sufficient indication for opening an acutely infected sinus, but I deem severe pain and extreme tenderness with a marked increase of temperature ample reason for operating. A differential blood count may aid in determining whether to wait or to operate. Necrosis, producing orbital abscess and fistula, demands the external route.

Lesions of the eyelid, orbit and optic nerve, produced by sinusitis, should be treated by the external route which is more direct and

thorough, even though some cases may recover by the intranasal measures.

Cases, showing symptoms of intracranial complications, a low grade of chronic septic poisoning, such as rheumatic pains, sallow complexion, rapid heart action, low resistance to infections, and anæmia; cases with discharge, headache, and tenderness remaining after an attempt at intranasal drainage; cases reproducing the so-called polypoid tissue; and lastly, cases needing intranasal treatment for a considerable period and patients who from nervous temperament or lack of time prefer a more rapid method by choice; in all such the external operation should be considered. The results in the same class of cases should be more satisfactory with Killian's method as it exposes to direct vision more of the cavities and their relations than does any other method and is probably safer, if the truth were known, but unfortunately accounts of the fatal cases from intranasal operations upon the sinus are rarely published.

Technique.—First, make several cross cuts by which, later, the wound can be more accurately closed. The incision starts well up on the side of the nose, slightly below the level of the inner canthus to avoid the plexus of veins about the inner part of the orbital brim and because the resulting cicatrix shows less here than farther down on the nose and cheek, the incision extending upward into the eyebrow as far externally as the X-ray plate reveals the sinus to extend. Drive the knife to the bone and bring it along until near the eyebrow, when the pressure is eased up and only the skin of the eyebrow is incised. Second, the skin of the forehead is pulled upward, so that the incision will lie over the superior line of the bony bridge that will be made, and here the periosteum is incised from near the nasal bone, parallel with the orbital brim and about $\frac{1}{4}$ in. above it to a point a little farther externally than the sinus is known to extend, which outlines the upper margin of the bony bridge. The periosteum is elevated over a slightly greater area than the dimensions of the sinus. A pack of gauze, saturated with suprarenal solution, is allowed to remain under the elevated periosteum while the lower outline of the bridge and the inner boundary of the ethmoidal exposure is made by extending the previous incision in the periosteum on the side of the nose outward just along the orbital brim, as far as the floor of the sinus is suspected to extend. Elevate the periosteum first at the lower end of the incision where it is easily detached and carried backward until the lachrymal groove is fully exposed; then the orbital periosteum is elevated just above the

groove, backward, an inch or more, until the anterior ethmoidal vessels are felt. Carry the elevator upward behind the attachment of the trochlea, which is detached from the bone with the edge of a sharp curette from behind forward. All this is done under the disadvantages of an annoying hemorrhage. Pack the cavity with gauze, saturated with suprarenal solution and return to the anterior wall of the frontal sinus. The hemorrhage here will have ceased and the anterior bony

FIG. 154.—Cosmetic result after Killian's operation. Right side. The line of the incision is along side of the nose and in eye-brow, and is almost invisible. It was a medium-sized sinus. Note the slight depression above the eye-brow.

wall is removed, first by outlining the bony bridge with Killian's V-shaped chisel, and second by removing the entire anterior wall, searching carefully until all the recesses have been uncovered and the lining membrane removed from every part of the sinus. Special care should be given to the posterior side of the bridge and the lower and inner part of the sinus. Now go below and make the bony grooves that will outline the bridge and the ethmoidal route, first making a groove in the nasal process

of the superior maxilla from the nasal articulation to the lachrymal groove from before backward across the grain of the bone; then start a groove at right angles to this cross groove, upward along the articulation of the nasal bone and nasal process of the maxilla, then outward along the lower edge of the orbital brim as far as the floor of the sinus extends. Remove this shell of bone with chisel and forceps, exposing the lower part of the frontal sinus, fronto-nasal duct and anterior ethmoidal cells. The bony orbital wall is removed as far as it is in relation to the frontal sinus and to the ethmoidal cells, as far back as the anterior ethmoidal vessels, not only to give access to the deeper cells, but also to give a perfectly healthy external surface to what was the ethmoidal labyrinth. About an inch in, the anterior ethmoidal vessels will be encountered, emerging from the orbit into the superior part of the ethmoidal cells. Occasionally an ethmoidal cell is found wrapped around these vessels, and its removal requires great care not to wound the vessels. The infected ethmoidal cells should be entirely removed, not simply curetted. If the sphenoidal sinus is diseased, it is entered, and the anterior wall is removed, the balance of the treatment being done better afterward. Gauze is lightly packed along the operative track and brought out of the nose, and finally the wound is accurately closed with metal clips, and a wet boric dressing is applied like the padding of a saddle, so that there will be no pressure upon the incision and the bridge, the gauze and clips being removed in 24 hours. This procedure, like the radical mastoid operation, for success depends mainly on perfect technical detail, portions of the membrane or a few small ethmoidal cells left behind spelling failure, and a careless opening and closing of the incision meaning disfigurement (Fig. 154).

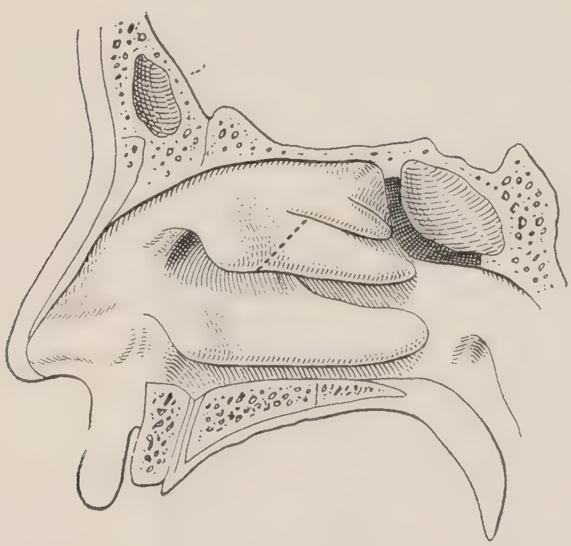

FIG. 155.—The dotted line shows the amount of the middle turbinate that has been removed to gain access to the sphenoidal wall. The dark portion of the anterior sphenoidal wall illustrates the portion that has been removed.

After-treatment.—The less the better. A little ointment, such as bismuth paste in the nostril several times a day is about all that is necessary. Watch the case closely and do little.

The sphenoidal sinus is usually associated with posterior ethmoidal disease. To gain access to the sinus (Fig. 155), the posterior half of the

middle turbinate has to be removed and then the anterior sphenoidal wall comes into view. The sphenoidal ostium is entered with a curette or forceps and as much of the anterior wall removed as possible. The lining membrane should be attacked with great caution because of the important structures in relation to this sinus, and when possible, it is better let alone.

SECTION XVI

SURGERY OF THE EAR

By

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Within the past two decades otology has advanced to the distinction of a dignified special field in surgery owing to its emancipation from empirical and obsolete practices to which it had been enslaved for half a century.

The practice of surgery of the ear should be based on the same sound and sane surgical principles as those employed in general surgical practice. Inflammatory processes localized in the ear depend on infectious foci and these should be sought for and surgically dealt with wherever possible; free incision of a circumscribed inflammation in the auditory canal or in the membrana tympani, should be utilized rather than small punctures with inefficient instruments, old-fashioned dressings, poultices and washes.

Drainage is as vital a feature of success to ear surgery as it is to the surgery of any other part of the body; unfortunately the deeper structures of the ear are often difficult of inspection and of access and this offers additional handicaps to effective work. Reforms in otological practice have been numerous and will be considered minutely in their respective chapters. The keynote of this volume is practical surgery and we will endeavor in this section on otology to eliminate all empiricism, unnecessary anatomical and physiological details, bibliographical data and elaborate illustrations. This will necessitate the omission of much pathological discussion and many therapeutic suggestions to be found in the usual text books on otology.

CLASSIFICATION

For convenient practical and clinical classification we recognize three subdivisions: (1) THE EXTERNAL EAR; (2) THE MIDDLE EAR; (3) THE INTERNAL EAR.

The External Ear.—The external ear includes the cartilaginous structure of the auricle with its various ridges and fossæ and its extension inwards forming the external auditory canal, tortuous and hour glass in shape in its cartilaginous portion and terminating at its distal end in the annulus tympanicus in which the membrana tympani is spanned. The auricle, composed largely of elastic cartilage, is continued as the external two-thirds of the external auditory canal and is covered with a rather thin integument, contains comparatively few of the glandular elements of the skin and has a very limited vascular nourishment. This limited vascular nourishment and the close adhesion of the thin layer of skin to the perichondrium, makes the external ear intensely susceptible to acute pain with only the smallest focus of infection.

Furunculosis.—A furuncle of insignificant size, when occurring in the skin of the auricle or of the external auditory canal, may produce excruciating pain because of the active tension on the surrounding tissues. An infectious focus of so slight a character in any other part of the integument where more elasticity and looseness exists would be unnoticed. An intense pain in the meatus of the auditory canal may produce so slight a macroscopic change to the eye of the otologist that he is prone to underrate the pain and discomfort of which the patient complains. The site of infection may be even overlooked during an examination when the otologist passes a speculum into the auditory canal and covers the focus of infection from view. Only by the patient's repeated wincing when the pressure of the speculum over the sensitive part becomes unbearable is the observer's attention called to the fact that some small infected hair-follicle or cerumen gland, has escaped him.

In the external auditory canal a more extensive form of dermal and cellular infection is possible because of the larger size and depth of the follicles contained therein. These are the hair-follicles from which spring the vibrissæ that protect the auditory canal from the invasion of dust, small insects and other foreign particles, and the group of cerumen glands located in the external third of the canal and just beyond the meatus. These cerumen glands often have a very deep and winding course and extend to the lowest layers of the skin and underlying subcutaneous tissues. Infection of such a deep hair-follicle or cerumen gland may become so intense that a marked infiltration or induration of this part of the auditory canal ensues and the entire lumen of the auditory canal may be temporarily closed thereby.

Furunculosis of the auricle, or as it is more commonly prevalent, of the external auditory canal, is not only a very painful condition to the patient but often a very troublesome affection for the otologist. If furunculosis always occurred in an isolated follicle and was self-limiting in character, it would not deserve so close a consideration, but it often affects groups of follicles; patients who have contracted one infection of this character are peculiarly susceptible to recurrences and re-infections.

The most effective treatment for furunculosis is free incision, a careful cleansing of the exudate and pus from the auditory canal, and an antiseptic dressing in the canal to prevent further infection. When additional follicles are attacked and the process continues, either autogenous vaccines or stock vaccines prepared from the pus producers found in this class of infections will be of inestimable value as a therapeutic measure.

My usual procedure in the treatment of furunculosis auris is as follows: If seen in its incipient state the surface of the furuncle may be washed with a swab of 98 per cent. alcohol and painted with tincture of iodine. In twenty-four to forty-eight hours the pain and inflammatory character of this localized infection will either have ceased or become so aggravated and sensitive that incision with a small furuncle knife is called for. The incision should be made through the furuncle to the depth of the follicle and the slight bleeding that follows should be encouraged. If pus has already formed I find it practical to take a large-sized Gruber speculum and press firmly around the edge of the incision to evacuate the contents of the infected follicle. The exudate and blood should be washed out of the auditory canal with a warm 1:2000 bichloride or 2 per cent. carbolic acid solution, or mopped out with pure alcohol. The canal is then dried and a small gauze strip saturated with 20 per cent. carbolized gylcerin, is lightly packed into the auditory canal beyond the area of infection. The dressing is changed in 12 hours, the parts inspected for possible freshly-infected follicles and a similar gauze strip inserted.

A free purge is prescribed when the patient is first seen and all of the eliminating organs stimulated to full capacity.

In protracted cases vaccines have frequently been very effective in my hands when other measures have failed. Stock furunculosis vaccines, or as it is more familiarly known as furunculosis bacterin, composed of the various pus producing organisms, isolated from boils and carbuncles, is used as follows: initial dose should not exceed 100

to 150 millions; within five days a second dose of 200 to 250 millions may be given; the third dose five days later may be increased to 300 or 400 millions. I have never found it necessary to use more than four such doses. Vaccine is administered subcutaneously by hypodermatic syringe in the usual manner and I have never yet seen any untoward results when these conditions are carefully complied with.

When the infectious condition has subsided and the skin of the auditory canal has cleared up, it will often be found necessary to lubricate the surface of the auditory canal with a little simple ointment, to prevent a dry, scaly eczema that frequently ensues.

DIFFUSE INFLAMMATION

The above procedure may be applied not only to localized furunculosis of the external auditory canal or auricle but also to a more diffuse inflammation or cellulitis affecting these areas. Here more liberal and more frequent incision may be necessary and frequent changings of dressings; it may even be found necessary and will do much to alleviate pain, to order the patient to bed and direct a constant douching of the auditory canal with half of 1 per cent. lysol in water at a temperature of 110° to 115°F., and repeating this douching with quantities varying from 1 pint to 1 gallon as often as is thought advisable for the relief of pain and congestion and to carry off the waste products exuded in the ear.

Ot-Hæmatoma.—Wrestlers, boxers, football players and other athletes are frequently subject to rough handling about the auricle and the hemorrhage from some little capillary may cause a marked effusion of blood under the skin of the auricle; they may become more or less organized in irregular clumps or masses, permitting the so-called ot-hæmatoma. These blood clots should be carefully evulsed after incision with a sharp scalpel in the least conspicuous part of the surface of the auricle in which they are found; the surface should be painted with iodine and a collodion dressing applied to prevent infection during healing.

Frost-bite.—The old idea to rub a frost-bitten ear with snow or ice to save it from further trouble, is based on many years of experience by the layman with this class of cases. In a frost-bitten ear in which the circulation has been temporarily arrested and a localized gangrene may be imminent, experience has proven a valuable teacher in formulating the above customary procedure. Frost-bite should be treated very much like a burn, for they both depend on arrested circulation and

surface destruction of the involved areas. As the external ear is poorly supplied with blood-vessels, a too active interference or disturbance of these crippled tissues must not be indulged in. A frost-bitten ear should be treated very much like a burn of the second degree; the parts should be kept thoroughly at rest; if the skin is broken or blistered, camphorated oil, or even crude petroleum may be found a very effective dressing.

Foreign Bodies in the External Auditory Canal.—Foreign bodies in the external auditory canal may be of many varieties, viz.: animate or inanimate, rough or smooth, cereal and soft, or stony and hard; vegetable, mineral, or animal in character. The character and variation in the methods of removing a foreign body from the auditory canal depend largely on its character and consistency.

If a live insect finds its way into the auditory canal the first and safest step is to kill it before removing it from the ear. Small insects that reach the fundus of the auditory canal may do considerable damage by moving over the surface of the membrana tympani and bruising or tearing it in their struggle to get away. A few drops of chloroform instilled into the auditory canal, with the affected ear uppermost so that the chloroform may reach the surface of the drum membrane, is the quickest and most effective way of killing a living insect. Such an insect may then be dealt with as any ordinary foreign body and syringed out, or removed with the forceps, if practical.

A small bean, grain of corn or other cereal that has found its way into the auditory canal, should be removed without the use of water or other aqueous solution. When I was an undergraduate in medicine and the class in the dissecting room had finished its work on the "subject" and lots had been drawn for the skeleton, much time was spent in a careful cleansing of the bones. The difficulties in disarticulating the skull were easily surmounted by packing the entire skull cavity through the foramen magnum with dry navy beans and throwing it into a bucket of water over night. The next morning the swelling of the beans by the absorption of water, had produced sufficient pressure to beautifully disarticulate the skull without further effort.

This, in miniature form, is what takes place when a single navy bean or other cereal, lodged in the auditory canal, is subjected to a soaking process by any watery solution. The auditory canal is tortuous and hour glass in shape, and if the long axis of the bean happens to be in the narrowest diameter of the canal, the swelling of said bean may wedge it tightly in this spot and make it extremely difficult of removal.

For the removal of cereal foreign bodies, therefore, we may employ one of several forms of foreign body hooks, forceps, or spoons.

Much difficulty is encountered when a foreign body is smooth, hard and round, such as a glass bead, pebble, shoe-button without the eyelet, etc. If such foreign bodies have been tampered with before they are brought to the doctor, it is very likely that the fond parent or other well-wisher has succeeded in pushing the mass into the bony part of the auditory canal by means of hairpins, or other home-made surgical apparatus.

It is advisable and justifiable in many of these cases, especially in young nervous children, to administer a general anæsthetic so as to permit the operator to deliberately examine the canal and to remove the foreign body under good illumination.

In otology illumination is a more important consideration than when applied to any other cavity of the body, for it is difficult at best to see all of the various landmarks in the ear, and a good source of light and the proper use of the head-reflector, is of vital importance.

The most common form of foreign body in the ear is inspissated or impacted cerumen. When inspissated and of soft consistency, such a mass of cerumen may be readily washed out of the auditory canal by means of an ear syringe and alkalinized water. A scant teaspoonful of borax or soda in half a pint of warm water, will sufficiently soften and saponify the usual inspissated mass of cerumen. If, on inspection, such a mass of cerumen is found to be extremely hard to the touch of the probe, additional precaution should be taken to direct the patient to soak it thoroughly three or four times during 24 hours before the removal, with the following solution:

℞. Sod. Bicarbonat	gr. xv
Glycerini	ʒii
Aq. Destil	℥ii

This should be instilled warm into the ear three or four times in the 24 hours preceding the use of the syringe. It will then be found that the hardened mass of cerumen has been sufficiently softened to permit the pressure of the current of fluid to wash it out of the canal safely.

The Use of the Ear Syringe.—A few words about the proper use of the ear syringe may not be amiss.

The tortuous character of the cartilaginous external auditory canal, the peculiar plane which the drum membrane makes with the floor and walls of the canal and the sensitive and delicate structure of the drum

membrane all require some consideration when a current of fluid is projected with more or less force from a syringe into the fundus of the canal for the purpose of removing a foreign body. The accompanying illustration diagrammatically emphasizes this point (Fig. 156).

If fluid is projected from a syringe straight to the fundus or along the floor of the canal, it impinges with too much force at the acute angle that the membrana tympani makes with the floor of the canal and is likely to cause considerable mechanical damage, actual pain and in some instances even rupture of the delicate membrane. The characteristic procedure for this simple technique is to straighten the tortuous auditory canal by pulling the auricle upward and backward and pointing the tip of the syringe in a long angle toward the superior wall of the auditory canal. This ensures the current of fluid passing above the foreign body, impinging on the plane of the drum membrane at its least susceptible obtuse angle and reflecting the return current in this way toward the floor of the canal and by this pressure from behind the

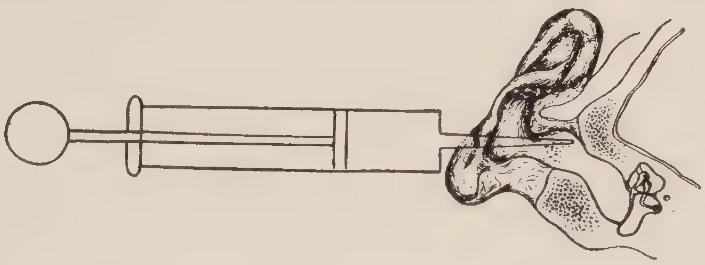

Fig. 156.—The aural douche.

foreign body washing same out of the canal with the least possible mechanical force.

It is an established axiom that any fluids used in the ear should always be used *warm*. There is no exception to this rule in otological therapy.

Tumors of the External Ear.—Tumors of the auricle and neoplasms of the external auditory canal should be treated as in other areas of the skin. Keloids, fibromata, papillomata, carcinomata, exostoses, hematomata, are the tumors of most frequent occurrence in the external ear.

Skin Lesions.—Eczema of the external auditory canal and auricle are of quite frequent occurrence. Among the most usual irritating causes may be mentioned neglected discharges from the ear in children; picking the auditory canal with the end of a toothpick, match, lead pencil, hat pin, or even dirty finger nail; the absence of cerumen which acts as a natural lubricant to the surface of the canal, or the extension

by continuity of surface of an eczematous process over the auricle into the external auditory canal.

In the case of children with a suppurative otitis media attention should be directed to the tendency of the child to put its finger into the ear and carry the pus-laden finger to the eye, scalp, nose, lips, or other parts of the head and thereby producing a similar infection there.

The local treatment of eczema in the ear is rather more difficult and stubborn than in other areas of the skin because it is difficult to apply an ointment or a lotion in a canal of such small diameter and the reaction is often inadequate because of the poorly nourished skin.

For eczema auris Ung. Hydrarg. Ox. Flav., with equal parts of Adeps Lanæ, may be found of much value; or Ung. Plumbi., where considerable itching is a symptom; or 5 per cent. Resorcin in Ung. Petrolati may prove effective.

The Middle Ear.—The anatomical and physical relationship of the tympanic cavity and its accessory areas is the foundation on which the entire pathology and therapy of diseases of the middle ear is based. The tympanic cavity is but a small irregularly shaped cuboidal space of about the contents of 8 to 10 drops of water. Normally it is in direct communication through the Eustachian tube with the nasopharynx, lined with a contiguous mucous membrane, and therefore may be logically and anatomically regarded as a part of the upper respiratory tract.

It is this very continuity of surface of the mucous membrane from the nose and nasopharynx through the Eustachian tube to the tympanic cavity proper, the additus ad., antrum, and ramification of mastoid cells that makes this series of small bone cavities constituting the middle ear an area of tremendous susceptibility to all forms of inflammatory and infectious processes.

This continuity of mucous surface in an area of liberal vascular and lymphatic supply is responsible for the frequent participation of the middle-ear cavity in inflammations, suppurations and other pathological changes occurring in the wake of various exanthemata. The eruptive fevers all have their origin of infection in the tonsils and fauces, and the close juxtaposition of the pharyngeal mouth of the Eustachian tube and direct extension through the tube to the tympanic cavity develops similar processes of infection in the mucosa of the tympanic cavity. Bacteriologically we can demonstrate, from the pus in the external auditory canal that finds its vent through the perforation of the drum membrane, the streptococcus, Klebs-Loeffler bacillus, the

various pus-producing microörganisms, and even in rare instances such an unusual invasion as that of actinomycosis into the tympanic cavity.

Mechanically the relationship of the Eustachian tube and naso-pharyngeal structures is an equally important factor in the production of affections of the middle-ear cavity. Twenty-five years ago the cause of 15 to 20 per cent. of acquired deafness in children in institutions for the deaf all over the world could be traced to excessive adenoid vegetations. In the most aggravated forms adenoid tissue had grown into the pharyngeal mouth of the Eustachian tube, obliterated the caliber of the tube, prevented the ventilation of the tympanic cavity, caused collapse of the membrana tympani, until its mucous surface had formed adhesions to the promontory and produced a serious mechanical type of deafness.

Since the discovery of the pathology of adenoid vegetations and the accepted surgical disposal of this tissue, the large percentage of acquired deafness has been greatly reduced. Today the pathology and surgery of the tympanic cavity and its accessory areas is based on a healthy comprehension and mastery of technique in the disposal of these affections.

DISEASES OF THE TYMPANIC CAVITY

The diseases of the tympanic cavity have been empirically divided into two groups: (*a*) suppurative otitis media; (*b*) catarrhal or non-suppurative otitis media.

Chronologically these two groups are again divided into acute, sub-acute, and chronic affections, the time limit constituting to a large extent the period of division.

Ear-ache.—Acute catarrhal or non-suppurative otitis media, or its more commonly known ear-ache, is usually a condition associated with an acute hyperemia or inflammation of some area of the upper respiratory tract in direct relation or continuity with the tympanic cavity. A small percentage of cases of acute otitis media may also be developed from a direct exposure to cold attacking the membrana tympani externally through the auditory canal.

The symptom which first brings us into contact with our patient is pain, varying in character, frequently coming on suddenly and rapidly increasing in intensity. Pain is especially aggravated in the case of children and is frequently accompanied by fever, delirium and intense nervous excitability. On examination of the ear the drum-membrane

presents an intensely hyperemic picture indicative of acute inflammatory reaction. If seen within a few hours the first change in the drum-membrane noticeable is a retraction of the plane inward due to a diminished air supply through the tympanic cavity by the narrowing of the caliber of the Eustachian tube with the onset of the inflammation. Now follows the exudation of serum or mucus into the tympanic cavity. The accumulated contents, when the capacity of the tympanic cavity is reached, bulges the membrane outward, the convexity depending on the quantity of fluid contained within the cavity and the pressure that is brought to bear on the membrana tympani.

When inspection reveals this intense convexity of the membrana tympani with a red, deeply injected surface appearance, paracentesis is emphatically and always indicated, the object of this incision being to relieve the middle-ear cavity of its pent-up fluid contents and inflammatory products, and also to save the drum-membrane from a spontaneous natural rupture which takes place as soon as the pressure exerted by the fluid can overcome the resistance of the delicate membrane. With this incision of the drum-membrane we release the fluid from the middle-ear cavity, relieve the pressure and hence the pain, and save the drum-membrane from a ragged, irregular perforation. An incision of this elastic tissue invariably heals in a short time if the process does not go on to suppuration.

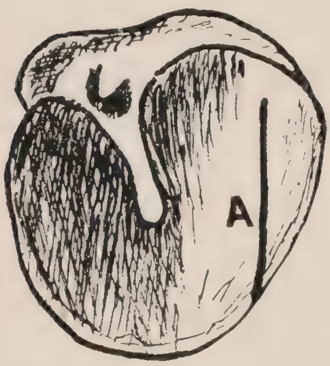

FIG. 157.—Myringotomy. *A*, Line of incision in the drum head.

The location and character of an incision of the ear drum is best indicated in the accompanying illustration (Fig. 157).

The middle layer of the membrana tympani is histologically composed of two sets of elastic fibers: (*a*) radiating fibers from the manubrium to the periphery; (*b*) circular fibers, ranged parallel with the annulus tympanicus. These two sets of fibers have as their function the maintenance of tension of the membrana tympani. If, therefore, we desire by our incision to effect satisfactory drainage of the fluid contents from the middle-ear cavity, and at the same time wish to conserve the further function of the drum-membrane, the area of incision should be made where the fewest of these fibers may be injured.

The membrana tympani is divided topographically into four quadrants: one imaginary line crosses horizontally with the manubrium as the diameter; the second line is a perpendicular to the first line bisecting the manubrium. These two lines divide the membrana tympani into

four quadrants: (1) anterior superior quadrant; (2) anterior inferior quadrant; (3) posterior superior quadrant; and (4) posterior inferior quadrant (Fig. 158).

Our line of incision extends from a point in the lower part of the superior posterior quadrant near the periphery of the drum-membrane and sweeps down to the floor of the membrana tympani.

The floor of the tympanic cavity lies lower than the floor of the external auditory canal at its juxtaposition with the tympanic cavity. It is, therefore, necessary, in order to insure adequate drainage, that our incision extend well down to the floor of the external auditory canal.

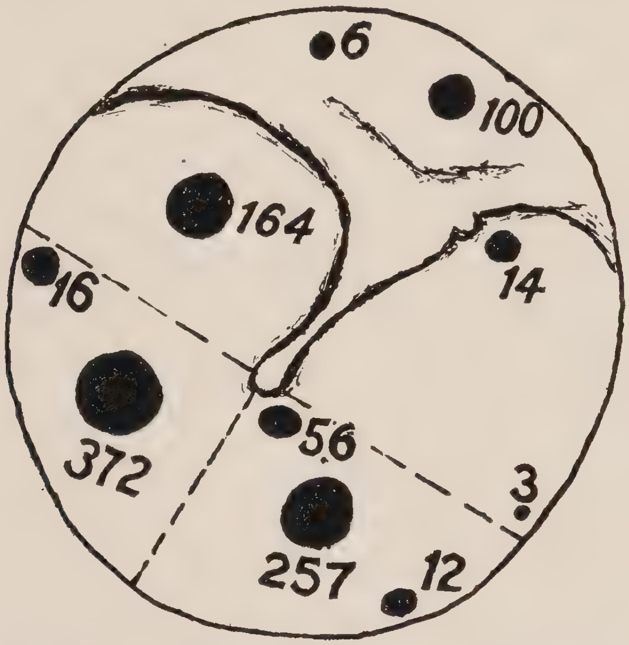

Fig. 158.—The dark areas represent perforations and the figures express the relative frequency of perforations in the corresponding localities of the membrana tympani based on 1000 cases. 6, 100, Perforations in Shrapnell's membrane; 164, perforation at the incudostapedial articulation; 56, perforation near tympanic orifice of Eustachian tube; 3, 12, 16, perforations near annelus; 14, perforation at neck of malleus; 372, perforation in post. inf. quadrant; 257, perforation in antero-inf. quadrant. (*Adapted from Randall.*)

Observation will corroborate the clinical fact that the higher the location of a perforation in the drum-membrane the longer the duration of the suppuration and the less adequate the drainage; the lower the perforation in the drum-membrane the shorter is the duration of suppuration and the more satisfactory the drainage. This is a simple mechanical as well as surgical principle.

To incise the drum-membrane satisfactorily, especially in children who are nervous and restless, a general anæsthesia, preferably by gas, somnoform or ethyl chloride is recommended.

After the incision the auditory canal should be lightly packed with a strip of sterile gauze and further protected by a small pledget of cotton

in the meatus of the canal. The source of the infection in the nasopharynx or pharynx should be carefully looked into. In acute coryza or acute nasopharyngitis the use of adrenalin as a local vasomotor constrictor to reduce the congested mucous membrane and a spray or instillation of camphor, menthol and carbolic acid in some form of hydrocarbon oil, offers a soothing and antiseptic application to these tissues. In young children a few drops of this oily antiseptic may be injected with a medicine dropper into the nose, the child's head being held well backward on the lap and the fluid allowed to reach the pharynx and medicate these areas.

A case of inflammation of the tympanic cavity in which a serous exudate or undue congestion of the mucosa has not been promptly recognized or given the necessary surgical drainage will, unless such exudate is absorbed spontaneously, become infected by one of the various pus-producing microörganisms responsible for the original trouble and then constitutes an acute suppurative otitis media.

Acute suppurative otitis media may also be developed *per se* in the course of infective fevers, influenza, diphtheria, tonsillitis, or other acute specific bacteriologic invasions of any of the mucous areas directly continuous with the Eustachian tube and tympanic cavity.

Acute suppurative otitis media after perforation of the membrana tympani, runs a more or less self-limited course of about three or four week's duration, unless some sequelæ occur. The treatment of an acute suppurative otitis media is again largely a matter of asepsis and proper drainage. If the pus exudating from the tympanic cavity, through the perforation of the membrana tympani, has a free exit, and the size of such perforation is sufficient to admit of liberal draidage and the position of said perforation is sufficiently close to the floor of the tympanic cavity, to ensure evacuation of its pus contents by such drainage, the prognosis is proportionately more favorable to thorough resolution.

Considerable importance should be attached to the bacteriological identification of the pus-producing microörganisms in each case. If a simple microscopic examination of the pus from the ear is made as a routine practice, a fair notion of the activity and possibilities of this localized inflammation may be obtained. When we demonstrate the presence of streptococcus pyogenes in such pus, extensive invasion and greater destruction of tissue between the tympanic cavity and its adjacent areas can be expected.

The several forms of staphylococci, if identified in such pus, indicate

a less vicious form of infection and one that produces less destruction and is more amenable to simple treatment.

If, in the course of the usual treatment of an acute suppurative otitis media we find a rise in temperature, diminution of discharge and tenderness over the area of the mastoid, we are justified in the conclusion that an expansion of the deeper seated areas of the tympanic cavity has taken place. If, in addition to these symptoms, we can determine a sagging swelling or œdematous change in the appearance of the posterior, superior wall of the external auditory canal, we have further corroborative evidence of the invasion of the mastoid antrum, for it is the expansion of such an infectious process to the antrum that produces the periostitis and infiltration of the deeper tissues responsible for such clinical, surgical symptoms. If such a surgical symptom-complex is found, my experience justifies me in the advice—operate without further delay!

An acute suppurative otitis media may, however, go on for a period of weeks and even months, passing chronologically into the more chronic form, causing no especial destruction within the tympanic cavity, and perhaps eventually, spontaneously, gradually draining and drying out. These cases are rather infrequent.

Much more frequently the perforation in the membrana tympani gradually becomes large as the drainage of pus continues through it, granulations are produced, polypi may be formed protruding through the perforation from the tympanic cavity to an extent where they completely fill the external auditory canal, a gradual erosion of the periosteum of the ossicles may take place, or the entire malleus and incus may be slowly absorbed in such a long-standing purulent process.

Much depends on the physical vitality of the patient as to the final outcome of such a chronic, suppurative process in the tympanic cavity.

The simple complications of chronic suppurative otitis media and their surgical attention may be briefly discussed as follows:

If the perforation in the tympanic membrane is large enough to admit of medication directly to the tympanic mucous membrane, it is my practice to dry the tympanic mucosa by cotton-tipped applicators passed through the perforation into the tympanic cavity, insufflate with boracic acid or aristol, or to lightly touch the parts with a 50 per cent. aqueous solution of argyrol and then pack in a 6-in. strip of narrow dry, sterile gauze, carrying the end of the gauze, if possible, through the perforation and packing the tympanic cavity and external auditory canal by zigzag fluting of the gauze.

Sterilization, dryness and drainage are the three factors in the most effective treatment of suppurative processes of any wound cavity, and the tympanic cavity is no exception to this empirical rule.

Granulations when present may be treated with 10 per cent. argentum nitricum, 50 per cent. argyrol, 2 per cent. acetate aluminum, or a saturated alcoholic solution of boracic acid. The nitrate of silver causes rather severe reaction for structures as delicate as those in the ear and is not always desirable; 50 per cent. aqueous solution of argyrol penetrates rather deeper than the silver but is not quite as astringent as the alcohol; acetate of aluminum may be effective if the granulations are soft and small; borated alcohol is a valuable dehydrant and acts in this capacity when instilled into the ear and left in position for some 10 or 15 minutes, producing a desiccation of such granulation tissue. When these measures fail a silver ring-curette is the most effective instrument for disposing of such granulation mass. The tympanic cavity may be thoroughly cocainized through the perforation in the drum-membrane and the curettement undertaken under usual aseptic precautions. Care should be exercised that neither the promontory wall nor the Prussak spaces are injured when such curettement is undertaken. Following the curettement the ear should be packed rather firmly with gauze, and the packing renewed every 12 hours for two or three days.

A well-organized polypus of the ear is usually attached by a somewhat slender pedicle to some part of the wall of the tympanic cavity in which erosion has taken place. The mass of the polypus most frequently forces its way through the perforation of the membrana tympani into the external auditory canal. Such polypi to be successfully removed must be engaged in the loop of an aural snare and removed by the pedicle. If the site of attachment of said pedicle can be located by inspection after the removal of this mass it may be touched by a probe tipped with a bead of pure chromic acid or of trichloracetic acid.

Bone necrosis occurring within the tympanic cavity may frequently be determined by the pus washings from the ear. These, when centrifugalized, will demonstrate the presence of bony particles when examined under the microscope.

Necrosis of the ossicles when occurring in the course of a suppurative otitis media, should be radically disposed of by ossiculectomy, the removal of the malleus, or of the malleus and incus, is not very difficult if a large perforation exists, and if the remnants of the ossicles are well

exposed. It may frequently be accomplished with the small ring-curette used in the disposal of granulations. The curette is passed well over the handle and neck of the malleus engaging the head of the bone with a gentle rocking upward leverage. The head of the malleus may be detached from its small suspension ligament in the attic. Where a gradual necrosis has existed in the course of a chronic suppurative otitis media these delicate ligaments will have been considerably weakened and the detachment and removal will take place with the expenditure of a very little force. The same technique is carried out on the incus. Extreme care must be used in the removal of the incus to avoid injury to or dislocation of the stapes. To avoid this complication the articulation of the tip of the incus with the neck of the stapes must be given attention before the curette is passed over the body of the incus preceding its removal. Complete anæsthesia of the patient is distinctly desirable for such ossiculectomy and the operation, slight as it may appear, should be done under strict aseptic precautions, the tympanic cavity thoroughly packed well up into the attic after the removal of the ossicles and the after-treatment carefully conducted to avoid an extension of inflammation or pus processes beyond the attic areas.

The Character of the Discharge.—Mucous secretion emanates from the tympanic cavity only. Epithelial débris, blood or cholestrin crystals may be found in the more advanced cases of chronic suppurative otitis media, usually significant of cholesteatoma. Bony particles found in the washings and centrifugalization of the discharge obtained in a suppurative process are indicative of bone necrosis, a thin watery sanguineous discharge suggests granulations, polypi, or occasionally even malignant neoplasm. Foul-smelling pus of a greenish character indicates bone necrosis, profuse yellow creamy pus of a slightly sweetish odor emanates from some part of the involved area where drainage is inadequate and where the pus-producing microörganism is more or less innocuous in character.

The diagnostic importance of the location of a perforation in the membrana tympani.

(*a*) A perforation situated in the antero-inferior quadrant is usually indicative of chronic salpingitis.

(*b*) The perforation in Shrapnell's membrane indicates disease of the attic, or of its ossicular contents.

(*c*) A perforation in the superior-posterior quadrant is usually associated with a necrosis of the ossicles, more definitely of the incus and of the margin of the aditus, or of the annulus tympanicus. Such necrosis

may even extend into the antrum. A perforation in either the anterior or posterior-inferior quadrant, is usually associated with a suppurative process in the floor of the tympanic cavity the chronicity of which is continued because the drainage is insufficient.

(*d*) In a large kidney-shaped perforation with a destruction of nearly all of the membrane vibrans is an evidence of previous intense acute inflammation and erosion as we find it so frequently in children following an invasion of the ear in the eruptive fevers.

ACUTE MASTOIDITIS

The mastoid antrum communicates with the tympanic cavity by a small opening called the aditus. This explains why acute inflammation of the mastoid is practically always secondary to either acute or chronic inflammation of the tympanic cavity. The disease generally starts in the nasopharynx and extends through the Eustachian tube to the tympanum and from there through the aditus to the antrum and mastoid cells.

Cases have, however, been described and unquestionably do occur in which the mastoid cells are primarily involved, there being no concomitant signs of middle-ear inflammation. Such cases are usually influenzal in origin and although the route of infection may be hematogenous it is more likely to be auditory, notwithstanding that the organisms, in their passage through the tympanic cavity, have not lodged there and given rise to inflammation.

Acute mastoiditis may follow prolonged exposure to wet or cold with consequent lowering of the natural resistance of the part and greater susceptibility to pyogenic infection. It may follow measles, scarlet fever, diphtheria, tonsillitis, typhoid fever, syphilis and tuberculosis.

The organisms that have been isolated from mastoid infections include the various streptococci, the staphylococci, pneumococcus, bacillus of Friedländer, bacillus of influenza, tubercle bacillus, the streptococcus mucosus capsulatus, etc. The last-mentioned organism is of special interest in a consideration of mastoid disease because it has a tendency to produce few clinical symptoms and a stringy, persistent discharge.

In a case of acute otitis media followed by acute mastoiditis it may happen that both mastoids may be involved simultaneously.

The presence of infectious material within the mastoid leads to

local necrosis with the formation of a sequestrum which is either discharged spontaneously or must be removed by operation. Usually the pus escapes by the most direct route and this is through the aditus into the tympanic cavity, and if there is a perforation in the drum, into the auditory canal. But if drainage is insufficient it will travel along the path of least resistance causing caries of the bone and, as the inflammatory process extends to the surface of the bone, periostitis.

The pus may become evacuated either (1) through the external mastoid cortex, behind the ear or the external meatus; (2) through the cortex into the digastric fossa with the formation of an abscess beneath the fascia of the sternocleido-mastoid muscle, forming what is known as *Bezold's mastoiditis;* (3) through the roof of the antrum or the tympanic vault into the middle cranial fossa; or (4) into the lateral sinus and the posterior cranial fossa.

The *symptoms* of acute mastoiditis will be influenced in their intensity by three factors: (*a*) the virulence of the infection; (*b*) the resistance to the escape of pus and (*c*) the stage of the infection.

There is usually a history of either acute or chronic middle-ear inflammation or attacks of earache with or without discharge. Even in an acute case otorrhea may be absent and in the subacute and chronic cases of middle-ear inflammation local examination may show no perforation and little evidence of trouble.

The two cardinal symptoms indicative of acute mastoiditis are: (1) *mastoid tenderness* and (2) *bulging of the postero-superior portion of the auditory canal.* Periosteal inflammation or the formation of a subperiosteal abscess will produce a characteristic forward and downward displacement of the auricle. The mastoid process will also feel boggy to touch and if the collection of pus be more considerable there may be fluctuation.

Fever is practically always associated with the pain. Where there is free escape of pus absence of fever is not, however, uncommon. The fever and the pain seem to be dependent upon the amount of pus retention. A low temperature is not an indication that the case is of but slight seriousness.

Persistent otorrhea is always regarded as a prominent symptom pointing to mastoid suppuration, especially when associated with mastoid pain. But not all cases of acute mastoiditis show any discharge. The discharge may be absent because there is no perforation of the drum; or the discharge may have ceased because of obstruction to the outflow of pus from the aditus, in which event examination of the

ear will show some evidence of recent suppuration; or there may be a history of previous discharge from the middle ear which had become blocked by granulations and polypi.

Pain is a constant symptom and, as already mentioned, is dependent in its intensity upon the amount of pus retention. In adults with sclerosis of the mastoid process, because of the greater difficulty to the exit of pus, the pain, fever and constitutional reaction may be extremely severe.

In determining whether or not the mastoid is diseased the X-ray has proven of great service, especially in those cases where there are few or indefinite symptoms. The results of X-ray examination have been so encouraging that for completeness of diagnosis röntgenization may be recommended as a routine measure in conjunction with the clinical examination.

In simple cases the *prognosis* is favorable. The longer the duration of the mastoid infection and the more advanced the local necrosis the greater is the danger of intracranial complications.

Treatment.—If seen in the first stage before pus has formed the patient should be given a calomel purge, followed by a saline cathartic, and immediately put to bed. If there is fluid within the tympanum the drum should be freely incised along its posterior border to facilitate drainage. The mastoid region should be painted with Churchill's tincture of iodine. Sometimes these expectant measures may produce improvement but if no amelioration of the condition is noticeable within 24 to 36 hours or if there is an aggravation in the condition operation should be resorted to without delay.

CHRONIC MASTOIDITIS

The pathological condition in chronic mastoiditis depends largely upon the variety of cellular structure of the bone. It may be composed of one of three chief types of cells: the *pneumatic*, in which the cells are few and large; the *diploic*, in which the cells are small and numerous; and the *compact*, in which the bone is extremely dense. If the structure be of the pneumatic or diploic types, caries may cause gradual absorption of the bone, the cavity thus formed becoming filled with granulations, epithelial débris and inspissated pus and communicating by means of fistulæ with the auditory canal anteriorly, or with the skin over the mastoid process externally or with the labyrinth, particularly with the inferior semicircular canal, internally.

Where the bone is of the compact variety a gradual process of osteosclerosis may ultimately make it of extreme hardness.

Except where there is an acute exacerbation of the disease with the clinical picture of an acute mastoiditis or an intracranial complication, the *symptoms* of chronic mastoiditis may be very vague. So long as drainage is unobstructed the temperature may remain normal. The discharge may be the only symptom. Headache, neuralgic pains, vertigo and tinnitus when present are to be attributed to some interference with the escape of the discharge. Pyrexia must be regarded as a danger signal for if it recurs or persists it is an indication that there is some pus retention within the mastoid or that there is an intracranial complication.

Examination of the ear will always show signs of chronic inflammation but such signs do not often tell to what extent the mastoid process is affected for the mastoid when opened may show greater destructive changes than were anticipated.

The diagnosis depends upon the history and signs of middle-ear disease with occasional symptoms of pus retention. The X-ray may be of great aid in clearing up the diagnosis and in differentiating the condition from furunculosis.

THE MASTOID OPERATION

Indications for the Simple Mastoid, or Schwartze, Operation.—

1. When there is an abscess over the mastoid process.
2. When there is persistent fever and pain in acute otitis notwithstanding that drainage is free.
3. When there is profuse purulent discharge with downward bulging of the supero-posterior wall of the auditory canal.
4. When there is empyema of the antrum and free drainage must be established.
5. When there are symptoms of meningeal irritation, even though drainage is free, especially if the condition is influenzal in origin.

Surgical Topography.—Where the upper posterior wall of the bony meatus terminates or merges into the outer surface of the mastoid there is a crescentic bony spine known as the *suprameatal* or *Henle's spine.* The center of this spine marks fairly accurately the position of the floor of the aditus. From the anterior portion of the zygoma and running backward and more or less upward upon the squamous portion of the temporal bone is a well-defined ridge forming part of the temporal

ridge. That portion of it which is above the bony meatus and Henle's spine is the *posterior root of the zygoma* which represents the level of safety in entering the middle fossa of the skull.

The *suprameatal or Macewen's triangle* is a triangular space between the lower posterior edge of the root of the zygoma and the superior posterior edge of the opening of the external auditory meatus (Fig. 159).

If we imagine a more or less horizontal line passing through the center of Henle's spine, its anterior extension forming an angle of about 15 degrees with the upper margin of the zygoma it will indicate with fair accuracy the horizontal portion of the facial canal on the inner wall of the tympanic cavity. If we imagine a vertical line

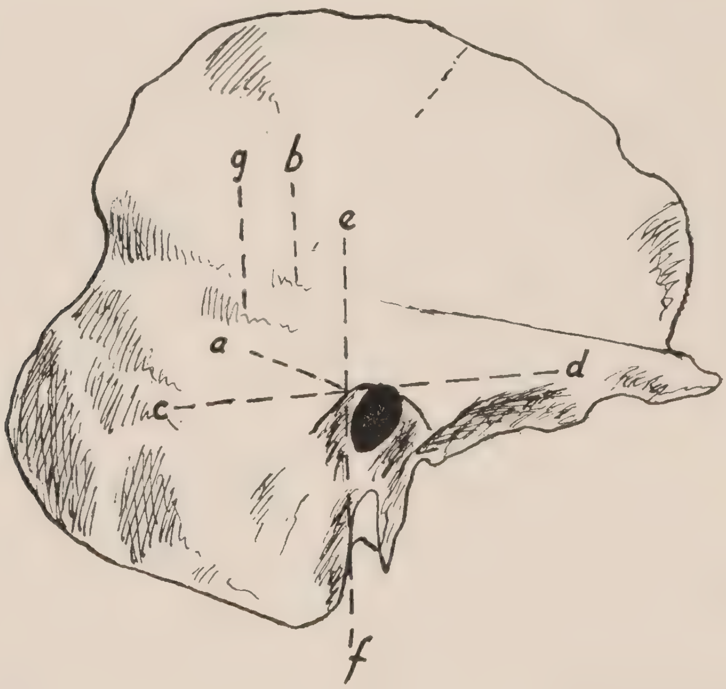

Fig. 159.—Surgical landmarks of mastoid cortex. *a*, Henle's spine; *b*, posterior root of zygoma; *g*, temporal ridge; *c–d*, direction of horizontal portion of facial canal; *e–f*, direction of descending portion of facial canal. (*After Kerrison.*)

passing through the center of Henle's spine it will be a fairly accurate guide to the descending portion of the facial canal, from its *genu* beneath the floor of the aditus to its termination in the stylo-mastoid foramen.

Description of the Operation.—The patient is prepared as for any other major operation. The head is shaved for 2 or 3 in. around the mastoid region and the operative field is thoroughly washed with soap and water, painted with tincture of iodine followed by alcohol.

Instruments Required.—Rongeur forceps of various sizes, retractors (Jansen's self-retaining), a mallet, a scalpel, chisels of various sizes, hemostats, periosteal elevators, gouges, sharp spoons, burrs,

clips or needles and needle holder, silk and catgut sutures, a seeker or probe.

Technique of the Operation.—While the auricle is gently held forward an incision, ½ in. behind the auricle, running in a curved line parallel with its line of insertion is made from the upper point of insertion of the pinna down to the mastoid tip. The position of the incision will depend upon the amount of infiltration and how much bond destruction is suspected (Fig. 160). It may be made further backward, if necessary, or its curvature may be increased. For additional space an incision at right angles to the first may be made.

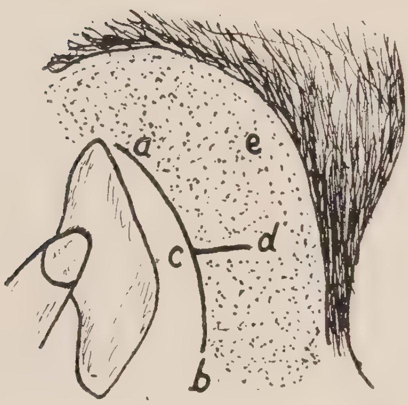

FIG. 160.

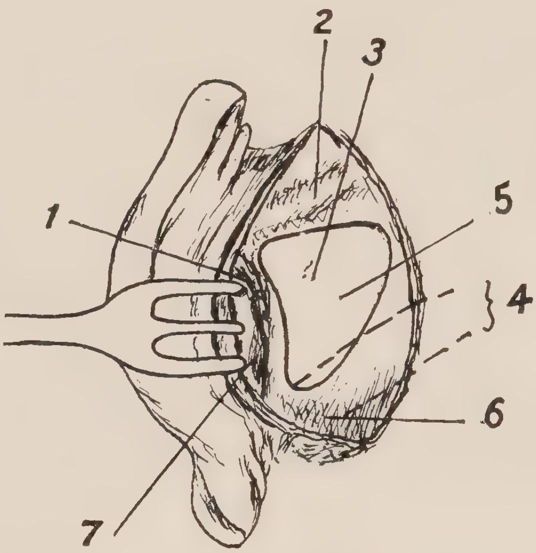

FIG. 161.

FIG. 160.—Showing initial incision for mastoid operation. *a–b*, *c–d*, incisions; *e*, shaved area.

FIG. 161.—Macewen's triangle. 1, Henle's spine; 2, posterior root of zygoma; 3, position of antrum; 4, position of lateral sinus; 5, area of bone removed in simple mastoid operation; 6, tip of mastoid process; 7, fibrous positions of post. wall of ext. auditory canal. (*Adapted from Tod.*)

The soft tissues are separated in front of and behind the incision by means of a periosteal elevator exposing a triangular area of bone (suprameatal or Macewen's triangle) bounded in front by the posterior upper margin of the bony meatus and Henle's spine, above by the posterior root of the zygoma and below by fibers of the sternocleidomastoid muscle (Fig. 161).

The edges of the wound are kept apart with retractors by an assistant or, better, by a self-retaining Jansen retractor inserted at each extremity of the wound. All bleeding points should be immediately arrested by hemostats and then tied if ligation seems necessary.

When the surface of the bone has been exposed by the separation of its periosteum any softened portion of the mastoid cortex should be removed by means of a curette or a rongeur forceps.

To reach the antrum the bone is chiselled away by means of a gouge held in contact with the bone in a sloping direction and tapping the instrument with a mallet. This procedure is carried out in a downward and forward direction.

Granulations and carious bone that may be present are curetted away.

The operative field should be constantly kept clean and dry by sponges of sterilized gauze.

When the antrum is opened any pus that exudes must be wiped away at once. Granulations, carious bone and cells communicating with the antrum should be removed by curette. This part of the operation must be fairly radical removing, if necessary, all the cells down to the tip of the mastoid process and exposing the dura mater and the lateral sinus.

It is not enough to thoroughly cleanse the main abscess cavity. There are a few cellular spaces above the meatus in the root of the zygoma any of which, if left, may lead to the formation of a discharging sinus or fistula. Hence it is advisable, to obviate this possibility, to make the bone cavity larger by chiseling away the overhanging edge of bone above and behind the meatus at the root of the zygoma. Also, near the tip of most mastoid processes, even of the diploic type, a large cell is present which it is best to expose and if found to be filled with granulations or infectious material these should be curetted away until the cell is thoroughly cleaned and normal bone laid bare.

Where this cell has undergone abscess formation perhaps with perforation through the median wall and gravitation of pus into the deeper tissues of the neck (Bezold mastoiditis) it will be necessary to remove the entire tip of the mastoid. For this purpose the incision through the skin should be lengthened along the anterior border of the sterno-mastoid muscle, the muscular attachment at the tip severed and the tip removed with a rongeur forceps or with a bone gouge.

The mastoid cavity having been curetted until healthy bone is reached the rough edges are smoothed down by means of a chisel or burr.

The wound is then flushed out with sterile water or with 1:5000 bichlorid solution and if the tympanic membrane contain a perforation the aditus and tympanic cavity are also syringed so that the fluid flows out of the external meatus. A strip of gauze should be inserted into the ear for drainage.

The mastoid cavity is now packed with iodoform gauze and the edges of the wound sutured or held in apposition by means of Michel's

metal clips, a free opening being left for the drain. The wound is then dressed.

After-treatment.—As a rule, the first dressing may be allowed to remain for three or four days. During the first day or two after the operation it is not uncommon to have a somewhat intermittent temperature. This should occasion no alarm unless it is associated with vomiting, inequality or sluggish reaction of the pupils or other cranial symptoms.

The succeeding dressings may be changed every other day. The drain is removed and the cavity syringed out with sterile water or boric acid solution and a new drain of sterile gauze inserted. The syringing may be omitted if there is no pus or abundant secretion. The most scrupulous care should be taken in regard to cleanliness and asepsis. The silk sutures or the metal clips should be removed by the third day to prevent sloughing.

Indications for the Radical Mastoid Operation.—

1. Acute mastoiditis associated with chronic suppurative otitis media.
2. Cholesteatoma, from which septic thrombosis is likely to occur.
3. Intracranial suppurative lesions.
4. Tuberculosis of the middle ear.
5. Fistulæ of the mastoid process.
6. Pus retention within the antrum and mastoid associated with repeated attacks of vertigo, nausea and headache. Retention, also, from recurring polypi and granulations.
7. Purulent labyrinthitis.
8. Facial paralysis occurring in the course of chronic suppurative otitis media, which signifies that the inflammation has attacked the Fallopian canal and is extending to the internal ear.

Description of the Operation.—The patient having been properly prepared for operation a curved incision, with another at right angles to it for additional space, is made behind the auricle, as in the simple mastoid operation. The soft parts and the periosteum are then pushed aside with an elevator until the suprameatal triangle is exposed; the operative field is kept open by means of retractors, as in the simple mastoid operation.

As in the simple operation the antrum is entered and the cavity enlarged by curette. Inspissated pus, necrotic bone and granulations are thoroughly removed with a sharp curette.

The posterior wall of the membranous portion of the auditory

canal is separated from the posterior wall of the bony portion and drawn forward by means of a retractor, together with the auricle, and held out of the operator's way by an assistant (Fig. 162). The wall between the auditory opening and the opening into the antrum is now removed in wedge-shaped fashion by chiseling from above downward and from below upward. This bridge of bone must be removed in order to get to the attic and tympanic cavity, because the object of the operation is to convert the interior of the mastoid, the tympanic cavity and the auditory canal into one chamber.

This step is one of the most difficult in the whole operation because the facial nerve, lying in the Fallopian canal, runs directly under this bridge of bone and the lumen of the aditus lies between the nerve and the bridge. In the floor of the aditus, also, lies the horizontal

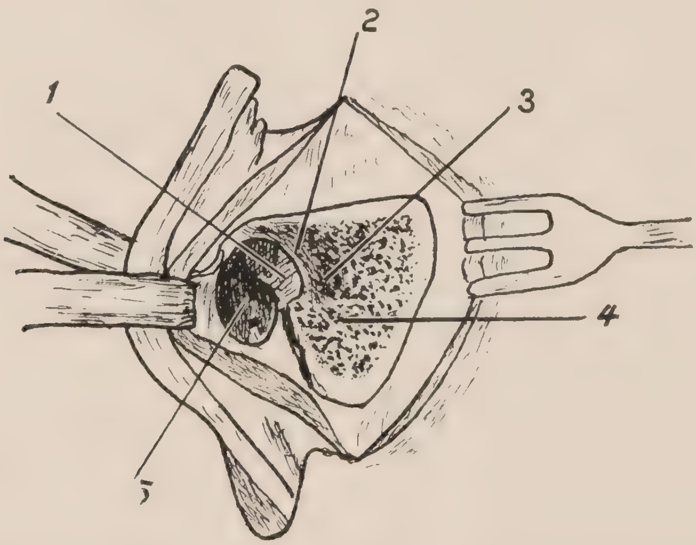

FIG. 162.—1, Semicircular canal; 2, attic; 3, antrum; 4, mastoid; 5, inner wall of tympanic cavity. (*Adapted from Tod.*)

semicircular canal. To prevent accidental injury to these structures a Stacke protector should be used; but if too much pressure be placed on the instrument in the course of removing the bone the facial nerve may be injured by crushing.

Instead of using the chisel and Stacke protector in the removal of the bridge of bone the Kerrison forceps may be employed. This is used in the following way: The beak of the instrument, which serves as a protector, is very gently inserted through the aditus. By compressing the handles the cutting surfaces in the upper jaw of the instrument are forced through the bone which is thus bitten away.

The outer wall of the aditus having been removed the attic is explored and curetted so that all diseased bone and granulations are removed. As the facial nerve crosses the inner wall of the attic it is

safer, to avoid injuring it, to keep to the outer wall. The curettement should be continued until a clear view of the tegmen is obtained and there are no overhanging ridges of bone.

The attic is now lightly packed for a few minutes or thoroughly sponged in order to remove all blood and chips of bone.

The tympanic cavity having been exposed and opened, the stapedius muscle and the incudo-stapedial articulation are severed and the malleus and incus removed.

In order to prevent subsequent re-infection from the nasopharynx the mouth of the Eustachian tube may also be curetted so as to produce a scar and obtain obliteration of the mouth of the tube. But in doing this the position of the carotid canal, downward and backward, should be uppermost in the surgeon's mind because the employment of sharp instruments in that direction necessitates extreme caution and a very clear conception of anatomical relations.

The middle-ear cavity is sponged and inspected and thoroughly curetted.

The entire cavity is smoothed down by a chisel or burr so that there are no points of projection except the slight ridge, the remains of the posterior wall of the bony meatus, at the innermost extremity of which the horizontal semicircular canal is situated.

The bony cavity is flushed out with sterile water, boric acid solution or 1:5000 bichlorid solution.

It is then packed with sterile gauze.

Posterior meatal skin flaps are now made. The flap most generally employed is that of Panse in which the skin of the meatus is slit along its posterior surface to the concha where two right-angled incisions are made one upward and the other downward. These are stitched to the periosteum and subcutaneous tissue with catgut. Other flaps that have been recommended are the modified Panse or Y-shaped flap of Passow; the Körner flap made by two incisions, one along the postero-superior, the other along the postero-inferior border of the auditory meatus, starting at its median aspect out to the concha; the Ballance flaps made by an incision from the median aspect of the meatus to the concha and around the concha in the form of a hook.

The purpose of the flaps is to hasten epithelialization of the raw surface of the wound. The uncovered space between the flaps may be allowed to heal by granulations or may be grafted at the time of the operation or 10 days later by the improved Thiersch graft as described by Dench.

The operation is terminated by packing the wound with sterile plain or iodoform gauze and approximating the edges either with silk sutures or with Michel's clips, as in the simple mastoid operation.

A dry dressing is then applied over the whole side of the head and allowed to remain for four or five days unless pain, fever or other symptoms necessitate its earlier removal for inspection of the wound.

After-treatment does not differ from that of the simple mastoid operation. After the first dressing the wound should be dressed every other day unless there be purulent discharge when the dressing may have to be changed daily. The ear or wound may be syringed with boric acid or with 1:5000 bichlorid solution, if the discharge requires it, before being re-packed.

Granulations should be removed by curette and if they recur it may indicate that there is still a small patch of carious bone that requires removal.

The Conservative Radical or Heath Operation.—This operation, devised by Heath, is based on the theory that in most instances the Eustachian tube, instead of being a constant danger of re-infection, is able to drain the discharges from the attic and tympanum. The middle ear is, therefore, not exenterated. Throughout the operation all exploration of the tympanic cavity with a probe or other instrument is avoided and the drum-membrane and ossicles are preserved intact. When removing the posterior wall of the bony meatus down to the annulus tympanicus the bridge of bone overlying the aditus must be left intact, otherwise the tympanic membrane and the ossicles would be destroyed.

At the time of the mastoid operation the attic is thoroughly cleansed through the aditus by means of a syringe. With a Politzer bag air is blown into the middle ear and through the perforation in the drum so that retained pus, polypi and granulations are driven into the external auditory meatus from which they are easily removed.

The after-treatment consists in inserting a curved cannula through the middle ear and perforated drum-membrane. Otherwise the treatment is the same as after the other mastoid operations.

Suitable for the Heath operation are those cases of chronic mastoiditis in which the hearing and the ossicles are only moderately affected and in which the tympanic membrane is not only perforated but largely destroyed.

INTRACRANIAL COMPLICATIONS OF CHRONIC MIDDLE-EAR AND MASTOID DISEASE

Intracranial complications due to direct extension of the pyogenic infection from the middle ear will in a great measure depend upon the direction taken by the bone disease toward the cranial cavity. If the path of infection be upward through the petro-squamous fissure or along the petro-squamous sinus there will result either a temporo-sphenoidal abscess, an extradural abscess or meningitis of the middle fossa. If the path of infection be downward, through the floor of the ear, thrombosis of the jugular bulb will result. If backward, involving the mastoid cells, there may follow either an extradural abscess, lateral sinus thrombosis or cerebellar abscess. If, finally, the path of infection be inward to the petrous portion of the temporal bone there may result either suppuration in the labyrinth, meningitis or cerebellar abscess.

Extradural abscess is the most frequent complication; next in frequency comes lateral sinus thrombosis and finally intracranial disease.

Extradural Abscess.—Extradural abscess is more often the result of acute, rather than of chronic, suppurative conditions of the middle ear and mastoid. The most frequent etiological factor is influenza.

There is severe and persistent headache localized to the affected side, and moderate fluctuating fever. Localizing symptoms will depend largely upon the size attained by the abscess. When these are present there are signs of cerebral irritation and compression (twitchings and paralysis of the extremities of the opposite side, vertigo, vomiting, retraction of the neck). Aural discharge, aural and mastoid pain may be absent in atypical cases.

Sinus Thrombosis.—Lateral sinus thrombosis may follow middle-ear suppuration without any mastoid involvement chiefly through the communication of the lateral sinus with the superior petrosal sinus. It is ordinarily liable to thrombosis from mastoiditis because of the free communication that exists between it and the mastoid by means of the mastoid veins. The sigmoid portion of the sinus is the part most frequently attacked. The jugular bulb may become infected through the floor of the middle ear.

The thrombus is generally at first obstructive and not infective. Bacterial invasion only occurs later and then the thrombus undergoes softening and disintegration. Clinically, this distinction is of no importance because the preinfected period of the thrombus is not, as a

rule, recognized. Symptoms appear when sepsis appears. There is a sudden rise in temperature followed by a fall to normal or nearly normal and accompanied by rigor or profuse perspiration. This is then repeated so that we have a typical intermittent or remittent temperature.

Cases occur, however, where the infective thrombus becomes surrounded by healthy clot so that no septic material passes into the general circulation and there are no constitutional symptoms. There are local symptoms of headache, vomiting and vertigo.

Choked disc is present in about 50 per cent. of cases. A fundus examination should always be made for the presence of optic neuritis.

A complication of acute mastoiditis which is likely to obscure the existence of sinus thrombosis and thus lead to a fatality is pyelitis. Pyelitis may sometimes simulate sinus thrombosis. It may also be present in addition to the sinus thrombosis, as in a case recently seen by the writer, where it may be held responsible for the clinical condition and the characteristic temperature curve until these become too violent to be thus explained. By that time, however, operation for the sinus thrombosis will have been delayed too long. Hence, where the clinical symptoms, even in the presence of a pyelitis, are suggestive of sinus thrombosis it is perfectly justifiable to do an exploratory sinus operation to determine the presence or absence of sinus involvement.

Sinus thrombosis requires either a simple or a radical mastoid operation with free exposure of the lateral sinus and complete removal of the infected clot.

Brain Abscess.—Chronic middle-ear suppuration is the usual cause of this complication. The abscess is located in the temporo-sphenoidal lobe or in the cerebellum. The former is about twice as frequent as the latter and follows attic suppuration; the latter follows suppuration of the posterior mastoid cells.

The symptoms characteristic of brain abscess are those of (*a*) *intracranial pressure:* headache, vomiting, optic neuritis, slow pulse and subnormal temperature; and (*b*) *localizing symptoms.* Pointing to temporo-sphenoidal abscess are slow pulse, drowsiness or coma, paralysis of the opposite side, subnormal temperature, deafness of the opposite side, aphasia, if the abscess is on the left side. Pointing to cerebellar abscess are vertigo, nystagmus, staggering gait, absence of patellar reflex, facial paralysis (of the same side).

In temporo-sphenoidal abscess the radical mastoid operation,

as already described, should be performed and the post-auricular incision extended upward and forward around the upper border of the auricle and the flap turned back. The bone above the external auditory meatus is removed with the chisel and bone forceps and the opening enlarged so that the dura is fully exposed. If the bone is very dense the opening may be made with a trephine. This opening should be at least ¾ in. in diameter. If the dura, when exposed, is found to be of normal color and pulsating, the button of bone may be replaced. If, however, the dura bulges and does not show pulsation, an incision is made through the membrane and the brain explored for the abscess. For this purpose it is more advisable to use a sharp-pointed, long, narrow knife. A hollow trocar or needle may become stopped up with brain tissue and pass through the abscess without giving evidence of pus.

If the abscess is found the wound may be slightly enlarged to allow free escape of the pus and the abscess cavity is washed out with sterile normal salt solution to clear away inspissated or cheesy material too thick in consistency to flow out with the rest of the pus. By means of the Whiting encephaloscope the abscess cavity may be inspected, irrigated and a drain inserted without bruising the normal brain tissue.

In exploration of the temporo-sphenoidal lobe it should be remembered that an explorer or knife cannot be inserted for more than 4 cm. or 1⅗ in., without endangering the lateral ventricles.

After the abscess cavity has been thoroughly cleaned out a strip of iodoform gauze, ½ in. wide, with a selvage edge, is inserted by means of a slender dressing forceps through the encephaloscope and the whole cavity, but not tightly packed. Instead of a gauze dressing a soft-rubber drainage tube may be used, the tube emerging through the trephine opening.

The original dressings need not be changed for four or five days unless the drainage is profuse and the dressing requires earlier changing. The packing within the abscess cavity may become saturated with exudate and give rise to pressure symptoms. It should accordingly be removed at once and a new packing or a rubber drainage tube substituted. The gauze packing or the tube is gradually shortened at each subsequent dressing so that it should not act as a hindrance to the natural resumption of the brain of its normal dimensions.

Exploration for cerebellar abscess is carried out as in temporo-sphenoidal abscess except that when the abscess is located anteriorly and in the deeper part of the cerebellar hemispheres it is safer not to

use a knife but an exploring trocar and cannula. The Ballance cannula is so constructed that it may be left in position after the abscess has been penetrated and evacuated.

Treatment and subsequent drainage and dressings are the same as in temporo-sphenoidal abscess.

Meningitis.—This is fortunately a comparatively rare complication in middle-ear suppuration. With an infection of low virulence the onset may be insidious and manifested by irritability, irregular fever and dull headache. The latter increases in severity until it becomes the most prominent symptom. Headache is also most severe in cases with acute onset. As the disease progresses there will be delirium, vertigo and muscular rigidity of the neck, strabismus, nystagmus, dilatation of the pupils, optic neuritis; finally, coma, paralysis of the extremities, bladder, and rectum.

Treatment, if the meningitis is diffuse, will be without avail. If more localized the bone over the diseased area should be freely removed and the secretion washed away with sterile salt solution and the wound gently packed with sterile gauze.

The serum treatment of otitic meningitis has not been followed by much success.

SECTION XVII

INFLAMMATORY AFFECTIONS OF THE NECK

By

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I. ACUTE INFLAMMATIONS

A. **Pyogenic Infections of the Skin and Subcutaneous Tissues.**—*Boils.*—Infection of the hair follicles, usually with staphylococci, is often met with, especially in the posterior region of the neck at the upper part. The course of these infections differs in no respect from furunculosis in other parts of the body except that they probably cause more discomfort on account of their situation. The neighboring lymph nodes may become enlarged and abscesses may result. When this complication occurs, serious local and constitutional symptoms may develop. Owing to the numerous hair follicles, infection spreads easily from the original focus and boil after boil develops, a chronic condition of furunculosis resulting.

Treatment.—Constitutional remedies are indicated, such as hygiene, attention to the bowels, iron, arsenic, etc. Locally, the same treatment is used as for boils occurring in other parts of the body, such as evulsion of the hair and destruction of the initial focus with the cautery, or injection of carbolic acid followed by careful dressing to avoid infection of other follicles.[1] If cases are seen later, the focus may be lanced or may be allowed to open spontaneously. It is essential to protect the surrounding hair follicles from infection, and if fomentations are used, the surrounding parts should be protected carefully from the purulent secretion by smearing them with carbolized vaseline. If the lymphatic nodes suppurate they should be incised promptly to avoid the possibility of deep cervical cellulitis.

Carbuncles.—The origin of these infections varies. Some undoubtedly appear to result from infection of hair follicles, but others are caused probably by septic embolisms of the subcutaneous arteries. The infection occupies the subcutaneous tissue and the skin is involved secondarily. The inflamed focus is hard and poorly defined from its inception. Necrosis of tissue occurs early and it may spread rapidly,

[1] Bier's suction hyperæmia is valuable.—Editor.

sometimes occupying a very large area of the neck, reaching occasionally from the occiput above to the shoulder blades below and extending laterally as far as the sterno-mastoid muscles. In depth it may reach the laminæ of the vertebræ and destroy them, laying bare the dura mater. The *constitutional symptoms* may be very severe. The temperature is often elevated to 105° and the pulse is very rapid. Symptoms of septicæmia may follow and the patient may succumb. The prognosis is very unfavorable in patients affected with diabetes or Bright's disease.

Treatment.—Many of the mild cases can be treated by fomentations, assisted by crucial incisions to relieve pain and liberate the discharges. In cases which do not improve rapidly or in which the constitutional and local symptoms are severe from the beginning, energetic and heroic treatment is imperative. A general anæsthetic should be given, if not contraindicated, and incisions made into the necrotic mass free enough to enable the surgeon to remove the dead tissue completely. The living tissue at the bottom of the wound should afterward be cauterized carefully to prevent septic absorption from the raw surface.

B. **Pyogenic Infections of the Subfascial Planes of Connective Tissue.**—Deep pyogenic infections may manifest themselves in one of two ways: (1) In the form of an *acute œdema* which terminates rapidly in suppuration (Ludwig's angina); (2) in the form of *acute abscesses* resulting from the destruction of lymphatic glands, or rarely as the result of wounds, accidental or operative. The former is in the nature of an acute lymphatic infection of intense virulence, requiring prompt, free incisions, whereas the latter is usually more chronic in its course and can be treated by more leisurely and conservative measures.

Ludwig's Angina (*Submaxillary Cellulitis*).—This disease was described first by Ludwig in 1836, since which time it has received careful attention. The infection which goes by the name of Ludwig's angina originates in the submaxillary region as a distinct phlegmon, secondary usually to a primary focus in the interior of the mouth, such as an ulcer or an alveolar abscess. Careful bacteriological examination of the discharges from a number of cases has shown that many varieties of organisms are capable of producing this disease. In the majority of cases streptococci have been found, but quite frequently staphylococci and even colon bacilli are the causes. The first manifestation of deep infection is seen in the submaxillary region, the parts rapidly becoming œdematous and swollen. The infection is usually one-sided, but occasionally it may be bilateral. There is marked swelling be-

neath the jaw reaching as low as the hyoid bone, the tongue is pushed upward into the mouth and the sublingual ridge is unduly prominent. The jaws are fixed and the patient is unable to open his mouth. The secretion of saliva is increased and the breath becomes foul. Occasionally the source of the infection is plain, such as necrosis of the jaw, alveolar abscess or ulcer of the tongue or floor of the mouth, but quite frequently no such source can be discovered. The tongue is enlarged and œdematous and fills the mouth so completely that breathing may be difficult. The œdema may spread to the glottis with fatal results. As time passes the infection spreads from the submaxillary region into the cellular planes of the neck and passes rapidly downward along the course of the carotid vessels. The *constitutional symptoms* are very severe. There is high fever and often severe rigors. The type approaches that of acute septicæmia, which is often the cause of death in cases that do not receive prompt surgical attention. The *prognosis* is very grave. There is no tendency to localization, and death will occur in the majority of cases before the abscesses can open spontaneously. The mortality in neglected cases is always high, death occurring from septicæmia or from septic pneumonia.

Treatment.—As soon as the case is recognized a general anæsthetic must be given and free incisions made into the inflamed area. The best incision is one that lays bare the whole submaxillary triangle. It must be carried from the symphysis of the jaw down to the hyoid bone, curving outward and upward until it reaches the sterno-mastoid muscle opposite the angle of the jaw. The flap must be thrown upward until the submaxillary salivary gland is laid bare. Sometimes pus is found in the fascial space in which this gland lies and in some rare cases the gland has been found necrotic. If the infection has passed into the deep cervical planes, an incision must be carried from the posterior end of the first cut downward along the anterior border of the sterno-mastoid as far as the sternum. The carotid packet of vessels must be followed to the lowest point of infection, which must be carefully packed with iodoform gauze. The upper parts of the incision must be left wide open and drains carefully placed to insure free exit of discharges. Afterward, antiseptic fomentations should be employed. As in other forms of sepsis, careful constitutional treatment, such as diet, tonics, etc., is necessary. The effects of prompt surgical measures are often magical. The writer has seen cases showing marked septicæmic symptoms with profound depression recover so rapidly that they were able to sit up 24 hours after the operation.

Acute Abscesses of the Neck.—Acute pyogenic infections of the deeper planes of the neck usually result from the destruction of lymphatic glands, by organisms which have gained access from the mouth and tonsils during the course of scarlet fever and other exanthemata. Other sources of infection are wounds and infections of the mouth, scalp, face and neck. As a rule the deep glands, which lie along the internal jugular vein under the upper part of the sterno-mastoid, suffer, and the resulting abscess occupies this situation under the deep cervical fascia. More rarely they may occur in the submaxillary region. Occasionally the retropharyngeal glands may be affected, the purulent collection in this case lying behind the pharynx and causing a swelling which can be seen and felt between the fauces. Peritonsillar abscesses form a class by themselves, the pus in this affection spreading into the deeper planes of the neck without the intermediation of the lymphatic glands.

Pathology.—The cause of suppuration is almost invariably a staphylococcus, and hence the tendency is for the collection to become localized. In rare instances streptococci are present and the resulting infection is more diffuse and of graver import.

Symptoms.—Following a primary throat affection, the deep lymphatic glands, already enlarged and painful, show evidences of more severe inflammation. The soft parts around them become œdematous and they become lost in an area of deep induration. The natural outlines of the neck become obliterated (Fig. 163). The patient complains of severe pain and a feeling of tension. The temperature is high and the pulse is rapid. Rigors are not infrequent. Fluctuation cannot be detected until late in the course of the disease. As the case progresses a periglandular abscess forms which increases in size rapidly. It may spread downward and upward with great speed, following the course of the carotid vessels, or it may remain circumscribed and penetrate gradually through the deep, cervical fascia toward the surface. As would be expected, streptococcic infections are more diffuse than those caused by staphylococci. If the case is neglected, very serious results may follow. Locally, the whole neck may be infiltrated as low as the mediastinum. Constitutionally, septicæmia may result.

Treatment.—The abscess should be evacuated as early as possible. Under no circumstances should we wait for fluctuation. In the early stages, Hilton's method of opening the abscess should be employed. Later, free incisions may be necessary. The deep fascial planes must be opened freely at all hazards and drainage tubes carefully placed in the

cavity. If the infection has burrowed along the carotid vessels, the path of the infection *must be followed* to its termination and laid open freely. In retropharyngeal abscesses it is preferable in the early stages to open them through an incision along the posterior border of the sternomastoid. In large abscesses, with symptoms of urgent dyspnœa, the pharyngeal route is quicker and safer.

FIG. 163.—Abscess of neck beneath the deep cervical fascia. (*Bryant and Buck's Surgery.*)

II. CHRONIC INFLAMMATIONS

As the lymphatic glands are intimately associated with most of the chronic inflammatory affections of the neck, it seems the proper place to describe their anatomy in detail.

Anatomy of the Lymphatics of the Head and Neck.—The following description follows closely the classical one given by Poirier and Cuneo.

The lymphatic nodes of the neck may be described as forming a rough circle or collar placed at the junction of the head and neck, from each side of which a vertical chain stretches downward along the internal jugular vein as far as the upper aperture of the thorax. The

upper glandular circle consists of the following groups of glands (Figs. 164 and 165):

1. **The Suboccipital Group.**—The number of glands in this group varies from one to three. They usually rest on the insertion of the complexus muscle just outside the border of the trapezius. Ricord's gland, formerly considered of such importance in cases of suspected syphilis, belongs to this group. These glands drain the occipital portion of the scalp and their efferent vessels open into the upper glands of the substerno-mastoid group.

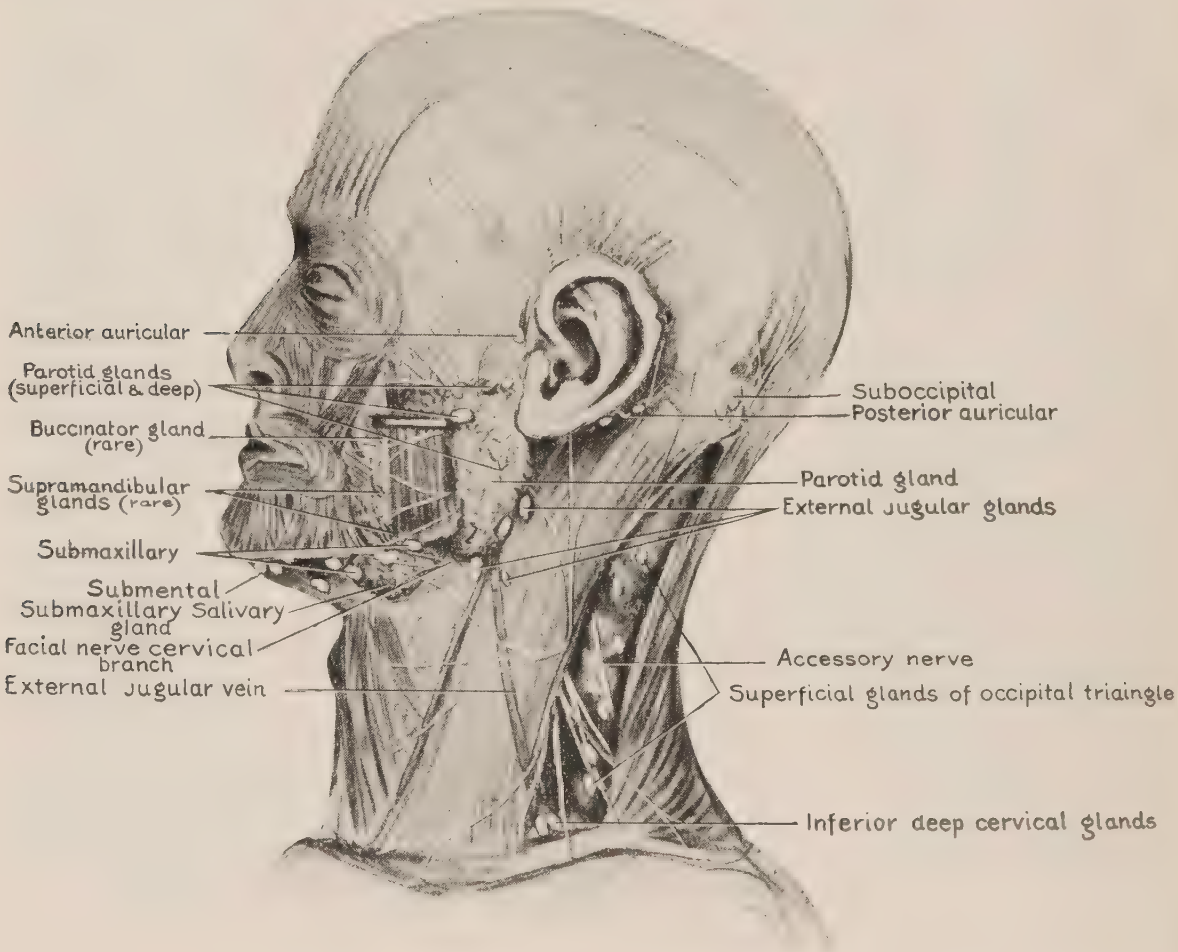

FIG. 164.—(*Keiller.*)

2. **The Mastoid Group.**—The number is usually limited to two, which lie on the insertion of the sterno-mastoid into the mastoid process. They are very common in children, but rare in adults. They drain the temporal portion of the scalp, the posterior surface of the auricle, except in the lobule, and the posterior surface of the external auditory meatus. The efferent vessels open into the upper glands of the substerno-mastoid group.

3. **The Parotid Glands.**—These glands, which are numerous, may lie either (*a*) just beneath the parotid fascia (superficial glands), or (*b*)

be placed deeply in the substance of the gland (deep glands). The former are usually found in front of the tragus and one of their number is often quite prominent (the preauricular gland) if enlarged. The latter are scattered usually along the branches of the temporo-facial vein, and are not confined to any part of the parotid gland. The afferent vessels drain the anterior surface of the ear and the external auditory meatus, the anterior portion of the temporal region of the

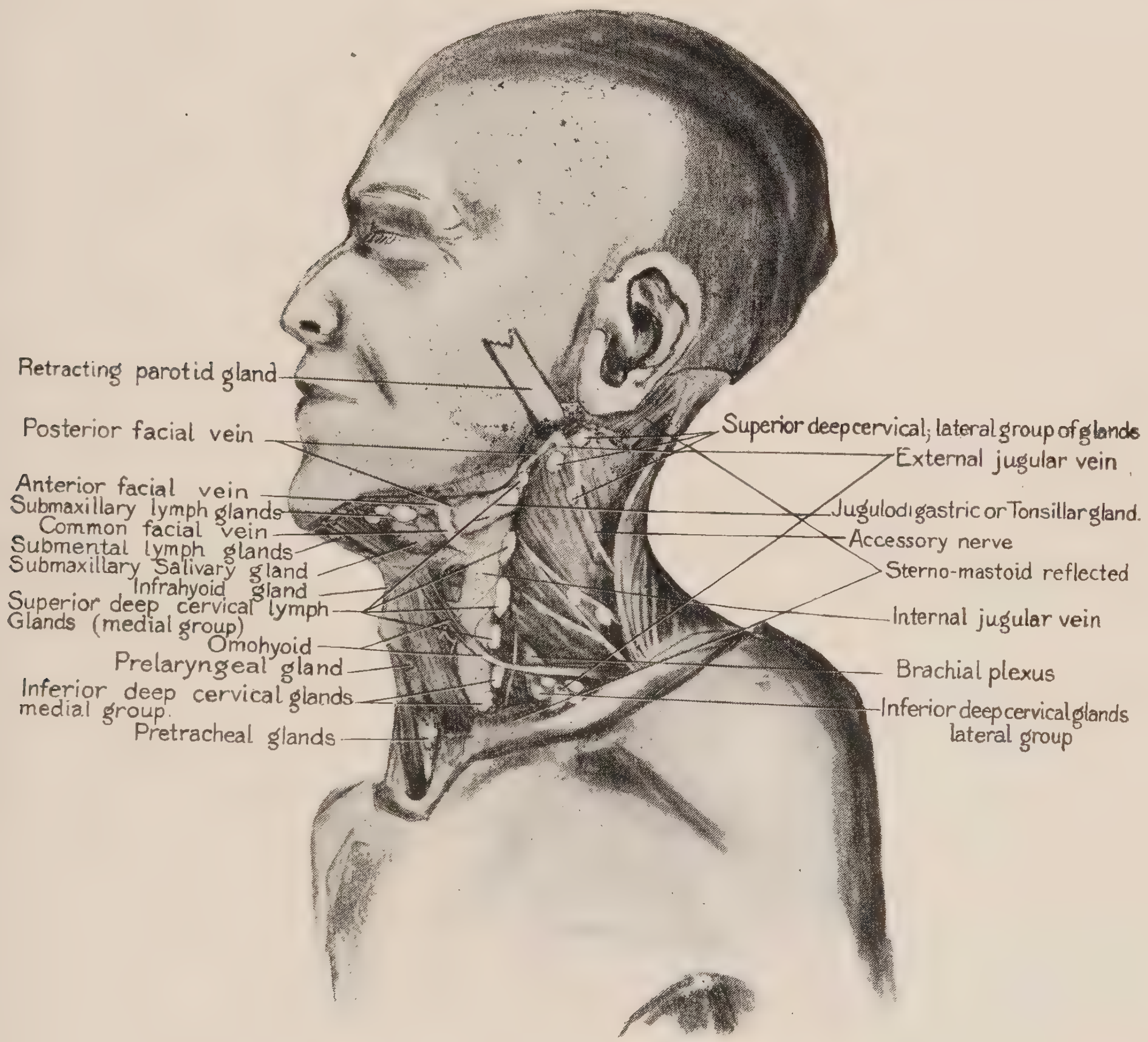

FIG. 165.—(*Keiller.*)

scalp, the frontal region of the scalp, both eyelids and the bridge of the nose. The efferent vessels empty into the upper glands of the substerno-mastoid group.

[During operation it is an anatomical impossibility to dissect all the glands from the parotid without destroying it and cutting the branches of the facial nerve. On this account malignant metastases in these nodes necessitate complete extirpation of the parotid.]

In addition to the glands above described, others are found lying

between the parotid and pharynx in the lateral pharyngeal space in contact with the internal jugular vein and internal carotid artery. To them the name of *subparotid nodes* has been given. Their afferent vessels drain the nasal fossæ, the nasopharynx and the Eustachian tube. the efferent vessels open into the upper glands of the substerno-mastoid group.

4. **The submaxillary glands** vary in number from three to six. They lie under cover of the lower border of the jaw, the anterior ones resting on the mylohyoid and the posterior on the submaxillary salivary gland. The posterior node of this chain is often large and is in close contact with the facial vein. The anterior nodes are usually deeply placed under cover of the jaw. The afferent vessels drain the nose (except the bridge) the cheek, the upper lip, the external part of the lower lip, almost the whole of the gums, and the anterior third of the lateral border of the tongue. The efferent vessels pass downward over the hyoid bone and open into the lower glands of the substerno-mastoid group about the level of the upper border of the thyroid cartilage. Some few of the trunks may pass still lower and open into a gland situated where the omohyoid crosses the internal jugular vein. (Supraomohyoid gland). In the afferent vessels of the submaxillary glands we occasionally meet with some small glands, usually along the course of the facial vein. They are often divided into three groups: (1) the *supramaxillary* group. The lowest of these is found in contact with the facial vein just above the margin of the jaw. It is quite commonly met with in cancer of the upper lip. (2) The *buccinator group*, situated on the buccinator muscle, is more rarely met. (3) *A superior group* (very rare) consisting of two or three glands occurring along the groove between the nose and cheek. (Some of these glands are shown in dotted outline in Fig. 164.)

5. **The Submental Glands.**—Three or four in number, are situated deeply in the space between the two anterior bellies of the digastric muscles. They lie in a single row reaching from chin to the hyoid bone. Their afferent vessels drain the middle portion of the skin of the lower lip and the chin, the corresponding portion of the alveolar border of the lower jaw, the floor of the mouth and the tip of the tongue. The efferent vessels pass in two directions. Some open into the submaxillary glands. The others pass downward over the hyoid bone and open into the gland above mentioned situated where the internal jugular vein is crossed by the omohyoid (supraomohyoid gland).

These five groups of glands just described form the cervical collar

or circle, and from the opposite sides of this circle the substerno-mastoid glands pass down along the jugular vein, hanging as it were, like cords from a hoop. Almost bisecting the upper cervical circle is the *retropharyngeal glandular group*. This group consists usually of two glands only, situated behind the posterior pharyngeal wall and in front of the lateral masses of the atlas. Their afferent vessels drain the mucous membrane of the nasal fossæ and the cavities connected with it, the nasopharynx, and the Eustachian tube. The efferent vessels pass, some in front, others behind the great vessels of the neck and open into the upper glands of the substerno-mastoid group.

The Descending or Lateral Cervical Chains.—On each side of the neck, situated under the deep cervical fascia and intimately incorporated with its layers, the deep cervical chain of lymphatic glands reaches from the level of the transverse process of the atlas above to the upper aperture of the thorax below. (Branching off from it are some accessory chains of more or less importance which will be described later.) The chain consists of a large number of glands and follows the course of the internal jugular vein. The upper part of the chain lies under the sterno-mastoid muscle, the lower part lies in the subclavian triangle. It may be divided conveniently into two groups, viz., the *substerno-mastoid* and the *supraclavicular* groups.

1. **The Substerno-mastoid Group.**—The glands of this group reach from the level of the transverse process of the atlas above to the junction of the internal jugular and subclavian veins below. The glands are very numerous above, but are rarely found below a point where the omohyoid crosses the internal jugular vein. They may be divided conveniently into the two following subsidiary groups:

1. *An external group* which is found along the posterior border of the sterno-mastoid muscle. The glands of this group are intimately connected with the branches of the cervical plexus and lie on the splenius capitis, the levator anguli scapulæ and the scalenus medius muscles, to which they are firmly bound by the deep cervical fascia. They blend with the glands in the subclavian triangle. Their afferent vessels come mainly from the occipital group of glands and the skin of the posterior portion of the neck below them.

2. *An internal group* which lies under the sterno-mastoid muscle in close contact with the internal jugular vein and its branches. The upper glands of this group are very constant and into them drain the vessels from the glands forming the cervical collar and the retropharyngeal glands. One of these upper glands deserves a special description.

It is probably the most constant of all. It lies in a triangle, one side of which (the upper) is formed by the posterior belly of the digastric muscle, the other two sides being formed by the fork made by the junction of the linguo-facial vein and the internal jugular. Cecil Leaf, in 1898, named it the "*jugulo-digastric gland*" and this is probably the

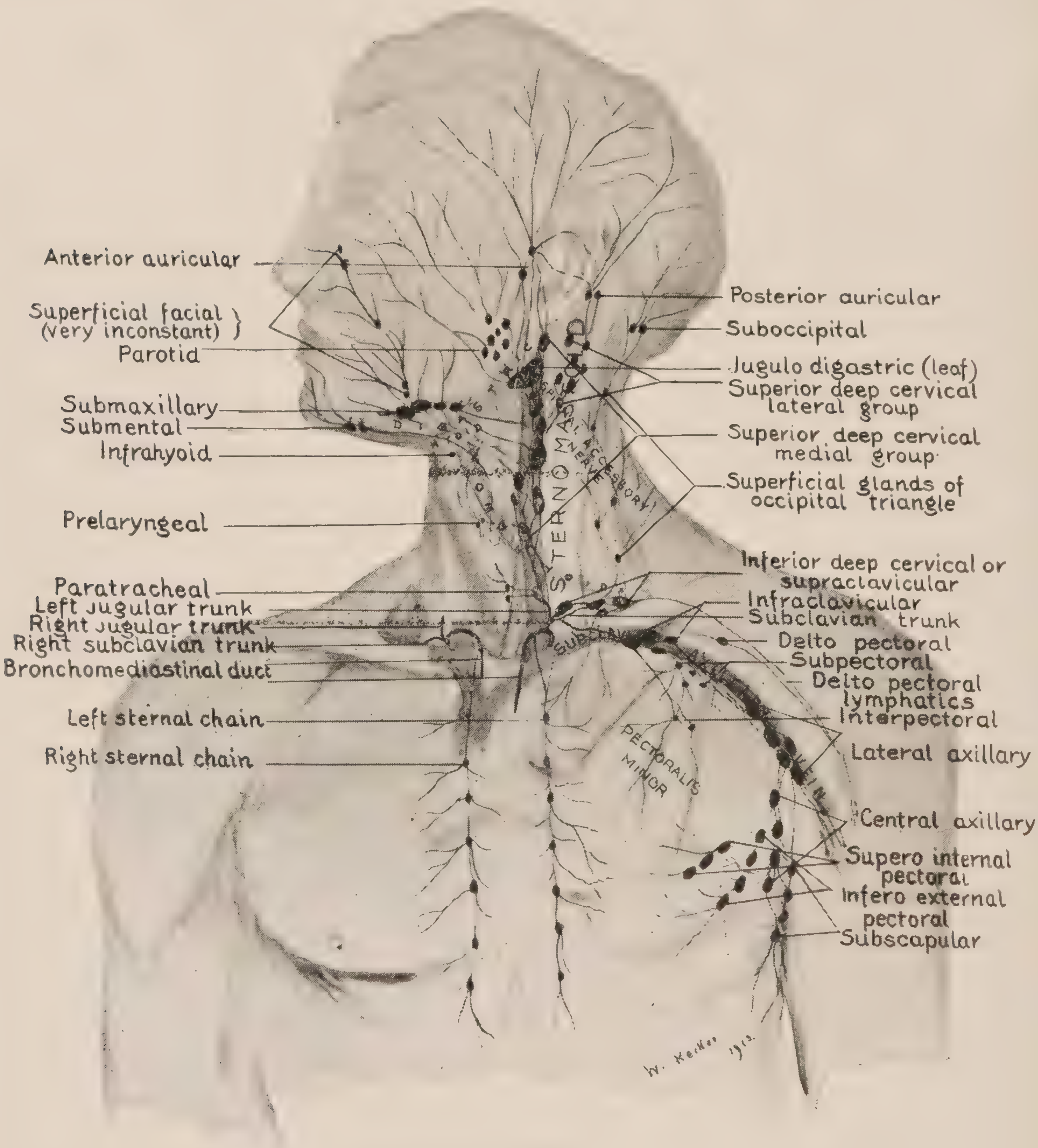

FIG. 166.—(*Keiller.*)

best anatomical name. Küttner, in 1898, called it the "Haupt" gland. Wood, in 1905, finding that it received directly all the lymphatics from the tonsil called it the "*tonsillar gland.*" Its importance will be appreciated when we remember that, in addition to receiving the efferent trunks draining the glands above it in the vertical chain, it receives directly the following: (*a*) the efferent trunks from the tonsils

and the contiguous portions of the palate and the tongue (Wood); (*b*) all the basal lymphatics of the tongue; (*c*) the greater number of the marginal lymphatics of the tongue, and (*d*) some of the central lymphatics of the tongue. The anatomical position of this gland can be studied in Figs. 165 and 166. Under ordinary circumstances the lowest gland of this internal group is placed at the point where the omohyoid crosses the internal jugular vein. This gland, to which the name "*supraomohyoid*" has been given, is very constant and is very important, because in addition to receiving the efferent trunks from the glands above it, it receives lymph, directly, from the following sources: (*a*) from the lowest submental gland; (*b*) some of the central lymphatics of the tongue; (*c*) (rarely) from some of the lymphatics draining the lower lip. Butlin writing in 1905 (Brit. Med. Journ., Feb. 11), emphasized the importance of this gland and advised its removal as a routine procedure in all cases of cancer of the tongue.

This internal group is without doubt the most important in the neck. In addition to receiving the efferent trunks from the glands forming the cervical collar, it receives direct lymphatic flow from the following parts: the tongue, the nasal cavities, palate, larynx, œsophagus pharynx, cervical portion of trachea and thyroid gland. All the efferent lymphatics from the internal group pass downward as one or two vessels, into which the efferent vessels of the supraclavicular glands join, forming a main trunk known as the *jugular trunk*, which joins the thoracic duct on the left side, while on the right side it opens separately into the junction of internal jugular and subclavian veins. (See Fig. 166.)

11. **The Supraclavicular Glands.**—This group of glands lies in the posterior triangle of the neck and is formed by a number of glands which are continuous above with those forming the external group of the deep cervical chain. The upper ones lie on the splenius capitis, the levator anguli scapulæ and the scalenus medius muscles, and are closely connected with the descending branches of the cervical plexus of nerves. The lower ones lie on the omohyoid muscle and are intimately connected with the termination of external jugular vein, the descending branches of the cervical plexus and the upper branches of the brachial plexus. The afferent vessels are derived from the following sources: (1) the skin of the occipital region of the scalp and the posterior part of the neck; (2) the skin of the pectoral and mammary regions; (3) some of the cutaneous lymphatics of the arm which accompany the cephalic vein (which occasionally pass over the clavicle instead of emptying into

the subclavian glands); (4) some of the axillary glands, especially those forming the humeral chain. Special attention should be called to the possibility of infection of these glands in cancer of the breast, following implication of the skin or axillary glands. Pyogenic infections of the radial side of the upper extremity are occasionally followed by direct infection of this group. The efferent vessels of this group unite with those of the substerno-mastoid glands to form the *jugular* trunk which (as mentioned above) opens into the thoracic duct on the left side and directly into the junction of the subclavian and internal jugular veins on the right.

It will be seen from the above description that the lowest glands of the lateral cervical chain are in close connection with the supraclavicular group and that infections can pass from one group to the other. It has also been pointed out that lymphatic trunks pass from the axillary glands to the supraclavicular group and that separate lymphatic vessels draining the arm (outer side) and the skin over the pectoral muscles drain into this group. In this manner the upper extremity and the mammary gland are brought in as tributaries. It is necessary, however, to correct in a most emphatic manner loose statements that the cervical and axillary lymphatics drain into the mediastinal glands. *There is never any direct connection.* All infectious material that filters through these glands passes directly into the venous circulation either by way of the thoracic duct or by separate lymphatic trunks which open separately into the subclavian vein. In Fig. 166 these points have been clearly pictured.

In addition to the groups forming the lateral chain described above, certain accessory chains may be mentioned. There are three in number:

1. **The external jugular chain,** consisting of two or three glands, is found along the vein of the same name. The afferent trunks drain the ear and parotid region and the efferent trunks open into the upper glands of the deep cervical region.

2. **The superficial anterior cervical chain** consisting of two or three glands is occasionally found along the anterior jugular vein.

3. **The Anterior Deep Cervical Chain.**—Scattered glands are occasionally found beneath the subhyoid muscles in front of the trachea and larynx.

Lastly, attention must be called to the presence of small glands which have been spoken of as interrupting glandular nodules. They are more often met with along the course of the lingual lymphatics and occur usually in two situations:

1. On the intralingual or central trunks lying in the substance of the tongue near its root, between the two geniohyoglossi muscles.

2. On the marginal or lateral lingual trunks. The usual situation is under the submaxillary gland, on the outer surface of the hyoglossus muscle, along the course of the lingual vein. (This glandular mass was described by Butlin, *loc. cit.* The writer has met with it, in one case of cancer of the tongue, as large as a pea and infiltrated with epitheliomatous material.)

TUBERCULOSIS OF THE LYMPHATIC GLANDS

The lymphatic glands of the neck are more often affected by tuberculosis than any other part of the body. Approximately about 90 per cent. of all cases of lymph-gland tuberculosis occurs in this region. The disease is oftener seen between the ages of 16 and 20 than at any other period of life. It is very rare before the second year of life.

Source of Infection.—It is probable that the majority of cases result from infection of the throat with tubercle bacilli. The faucial and pharyngeal tonsils are often affected with tuberculosis, and it has been found that tonsils apparently healthy are capable of harboring tubercle bacilli. Dieulafoy inoculated guinea-pigs with the faucial tonsils of children apparently free from tuberculosis and produced tuberculous disease in 16.4 per cent. of the animals. Tubercle bacilli have also been found in smears taken from nasal mucous membrane that appeared to be healthy. The frequency with which the jugulo-digastric gland (tonsillar gland of Wood) and the glands in its vicinity are affected with tuberculosis favors the claim that the tonsils are the usual port of entrance. Still it must be remembered that infection of any part of the buccal or nasal cavities such as may result from carious teeth, or from ulcers of the tongue or gums may irritate the glands and leave them less resistant to the growth of tubercle bacilli.

Pathology.—In the early stages the glands may show merely a hyperplasia. They are enlarged and surrounded by a thickened capsule, and often keep their original shape. On section they appear to be firm and of a pink color. Microscopically, there may be an increase in the quantity of fibrous tissue forming the tracebulæ. Tubercles are usually entirely absent. That these hyperplastic glands are in reality tuberculous has been proved by Blos who succeeded in inoculating guinea-pigs after injecting the glandular material into their peritoneal cavities. In the later stages, viz., those of caseation and liquefaction, the sepa-

rate glands of an affected group may show simultaneously every stage of the tuberculous process from hyperplasia to complete caseation. The tendency is usually toward degeneration, the gland substance being gradually destroyed and replaced by caseous material or thick tuberculous pus. The capsule may remain intact for a long period and may form a strong wall for the abscess. Occasionally the process is confined to a solitary gland. More usually, however, the infection spreads to the glands lower in the series and after a time the clinical picture reveals a chain of closely connected glands, in various stages of destruction. The inflamed glands contract adhesions to the surrounding structures, particularly to the veins, from which it is difficult to separate them during operation. In the early stages the disease is entirely confined to the glandular tissue. At a later period, if the capsule ruptures, the disease may spread into the surrounding muscles, such as the sterno-mastoid, which is often infiltrated.

Symptoms and Course of the Disease.—As a rule the enlargement is insidious and chronic from the beginning. It will often take a year for a gland to reach the size of a walnut. In rare cases the enlargement appears acutely. The writer observed two cases of this nature in one family apparently caused by infection of the tonsils. In one case, a boy aged 15 months, the left jugulo-digastric gland reached the size of a walnut in two weeks. It was removed together with two others in a hyperplastic condition (prëtubercular). A few weeks after, the jugulo-digastric glands on both sides of the neck, in another child of the same family, a girl aged five and one-half years, became acutely enlarged. Under local treatment they subsided partially, but never disappeared. Six years later the right jugulo-digastric swelled up again, and, resisting treatment, underwent caseation which necessitated its radical removal. At the time of operation four or five glands of the series were removed but none showed evidences of tuberculous infection.

The constitutional symptoms are slight, consisting of malaise and irregular low-grade fever. Not uncommonly the patients are apparently robust and well nourished. The group of glands oftenest effected is the upper substerno-mastoid group whose afferent vessels drain the fauces and posterior nares. The submaxillary and submental glands probably stand next in order of frequency. Occasionally, the infection localizes itself in the parotid or subparotid group. More rarely, some of the superficial glands along the external jugular or anterior jugular veins may be diseased. In the lower part of the neck the supraclavicular group is not infrequently affected. As the disease progresses, group

after group may be invaded in regular sequence. Thus, primary disease in the submaxillary group may invade the substerno-mastoid group and pass down the neck along both its internal and external divisions until it reaches the supraclavicular group which it may infect by direct contact. The final appearance of the anterior and posterior triangles in such extensive involvement is clearly shown in Fig. 167. In the majority of cases some of the glands first affected break down and discharge externally, so that necks, extensively involved, often

FIG. 167.—(*Bryant and Buck.*)

show numerous sinuses leading down to the caseous foci. The terminations of the infection vary widely. As in tuberculous affections elsewhere, the inflammation may subside and the glands may become greatly reduced in size. The infection is rarely completely destroyed. It is usually imprisoned and such infected glands are to be looked upon as a serious menace because the inflammation may flare up at any moment. Under ordinary circumstances some of the glands are very apt to break down and suppurate and, if the skin breaks, pyogenic infection is added and the resulting destructive process may continue in an irregu-

lar manner for years. Sometimes it may appear to be healing, at others to be spreading.

Prognosis.—Rather a large proportion of cases die eventually of pulmonary tuberculosis (from 15 to 20 per cent.) while others contract tuberculosis in other organs. Dowd quotes Demmer's statistics of the Jenner Children's Hospital in Berne. In 29 years work, out of 1692 children with lymph node tuberculosis

Developed tuberculosis of lung	145		= 21.0 per cent.
Developed tuberculosis of intestine	24	57 =	8.2 per cent.
Developed tuberculosis of pia mater	25		
Developed tuberculosis of kidneys	6		
Developed tuberculosis epididymis	2		
Total			= 29.2 per cent.

With a few slight differences these percentages agree with those given by other observers and indicate fairly accurately the destiny of patients affected with tuberculosis of the lymphatic glands.

Diagnosis.—In the early stages the diagnosis is very difficult. In delicate children, hyperplasia of the lymphatic glands will often follow the most trivial source of irritation, such as peptic ulcers of the buccal cavity, eruption of teeth, etc. The enlargement is often so marked and so slow to subside, that strong suspicion of a tuberculous involvement is aroused. Nevertheless, these glands eventually disappear under suitable treatment, hygienic and medicinal. Arsenic given as Fowler's solution will often cause rapid resolution of such inflammations. Some authors are inclined to look upon all such hyperplasias as being actually tuberculous, and point out that if the after history of such patients is followed carefully, a surprising number will develop tuberculosis in the glands previously affected or in some internal organ. While admitting that many hyperplasias result from tuberculous infection, it is not wise to accept such an extreme view of the question. It has been suggested (Dowd) that it would be wise to remove the affected node for diagnostic purposes, and there can be no rational objection to such a procedure when the enlargement resists medicinal treatment. A crucial test could be made by inoculating a guinea-pig with an emulsion of the gland. Hodgkin's disease may simulate tuberculosis. In the early stages of Hodgkin's disease, before the constitutional symptoms are evident, a differential diagnosis may be almost impossible. In both diseases the glands may be palpable and discrete. In the later stages the glands in Hodgkin's disease usually remain separate and feel like potatoes under the skin, while in tuberculosis the tendency is to fusion as the result of periglandular inflammation. Still later, the

severe progressive anæmia, intermittent fever, and gradual weakness, which accompany Hodgkin's disease and which are often altogether out of proportion to the apparent lymphatic involvement, are of great value. Enlargement of the liver and spleen are also of value as pointing to Hodgkin's. Blood counts are rarely of much value. They vary so much in both diseases as to be of little pathognomonic importance. From lymphosarcoma the diagnosis is usually easy. The extremely rapid growth, and extensive infiltration of all surrounding tissues, is so characteristic of lymphosarcoma that in a few weeks any doubts will be cleared up. From syphilis the diagnosis should be easy. In this disease the lymphatic glands are only slightly enlarged. They are hard and discrete, and they rarely soften or suppurate.

Treatment.—(*a*) *Medicinal Treatment.*—If hygienic measures are carried out carefully, medicinal treatment will often work wonders in lymphatic tuberculosis. It is not necessary to send our patients to the seaside to accomplish this, although in the British Islands, particularly, the benefit of sea air has been insisted upon. The outline of treatment is as follows: *Firstly*, all sources of irritation should be removed. This includes attention to digestion, the use of proper food, etc.; attention to the teeth and gums; attention to the tonsils, both faucial and pharyngeal, and to the nasal cavity. *Secondly*, various medicinal agents may be used. Foremost among these is arsenic. Iron and iodide of potash are of great value. *Thirdly*, local applications may be used, such as mercurial ointment. Strong local irritants seem irrational as they must be followed by a hyperæmic action which gives the lymphatic glands more work to do. The value of the X-ray is somewhat doubtful.[1]

(*b*) *Surgical Treatment.*—If employed early, surgical treatment is undoubtedly the most satisfactory way of treating tuberculosis of the lymphatic glands. The strongest argument against very early operation lies in the fact that the majority of glands in the so-called hyperplastic stage will disappear entirely under careful medical treatment. And yet the ease of performance and the total absence of danger in these early operations, added to the brilliant after results, is a very strong argument in their favor. Perhaps the rational view to take of the operative question is to reserve operation for those cases that resist *intelligently applied* hygienic and medicinal measures in their early stages. This course would give all cases of inflammatory hyperplasia and many cases of actual tuberculous inflammation a chance to subside spontaneously. If during the course of convalescence the subsidence

[1] Hyperæmia as advised by Bier is often of great value. (Editor.)

of the swelling is interrupted from time to time by a flaming up of the inflammatory process, operation should be considered. Exacerbations of the lymphatic enlargement at irregular longer intervals and without adequate cause should be considered as operative indications. One of the strongest arguments in favor of early radical operation lies in the feeling of most operators that they have no cause for regret after the operation is completed, because not only do they find that the glands attacked are extensively diseased, but that the tuberculous process has extended to other glands in the neighborhood.

The character of operation deserves some consideration. The superiority of radical excision over curettement is acknowledged at the present time by the great majority of surgeons. Curettement should be reserved for cases where the glands are so extensively affected that complete excision is impossible, and for cases where removal of the broken-down foci is imperative, but where radical operation is inadvisable at the time either on account of tuberculous involvement of other organs or of a lowered condition of general health. In the last group of cases there is always a prospect of performing the radical operation at a later date. The results of radical excisions may be considered under the heads of *early* and *late*.

The *early results* are very satisfactory. The immediate mortality is almost negligible if reasonable care is taken to avoid unjustifiable surgical risks, *e.g.*, patients affected with extensive tuberculosis in other organs. Early pulmonary tuberculosis is not necessarily a contra-indication. The patients recover very rapidly as a rule, and the healing process is very gratifying if care is taken to remove all infected tissue. Delay in healing can often be traced to tissue left behind in the wall of an infected sinus.

Late Results.—The value of statistics on the final state of these patients after a number of years have elapsed is diminished by the impossibility of tracing a large proportion of them. In Dowd's series of cases the results were as follows: Apparent cures in 77.9 per cent. of cases under 20 years of age, and in 57.2 per cent. of cases over 20 years of age. He also quotes from various reports that out of 1273 cases, observed from various periods of from 1 to 16 years, there were recorded *as cured* 57.65 per cent.; as having *local recurrence* 28.84 per cent.; as having *died*, mostly from tuberculosis, 13.51 per cent. There can be no doubt that if all the cases operated on could be followed, the percentage of deaths from tuberculosis in other organs would be higher than usually estimated.

CHRONIC INFLAMMATION

Actinomycosis of the Neck.—The ray fungus which is the cause of this disease enters the tissues of the neck either by direct inoculation of the skin or by extension of the disease from the jaw and cheek, or from pharyngeal and tonsillar actinomycosis. The disease does not appear to spread by the way of the lymphatic channels. Cases rarely come under observation in the early stages. The course of the disease is fairly rapid and when well developed the neck presents a character-

FIG. 168.—Actinomycosis of the neck. (*Lexer-Bevan, after Illich.*)

istic appearance. An indurated swelling is present, the margins of which are imperfectly demarcated from the surrounding healthy tissue. The skin covering the swelling is thrown into prominent indurated folds like the furrows of a ploughed field (Fig. 168). The color of the skin is reddish or purplish. In some places fluctuating spots are present; in others, sinuses have developed from which pus is discharged containing the characteristic yellow granules of the fungus. The swelling is often extensive, interferes materially with movements and renders swallowing and even breathing difficult. The constitutional symptoms are not severe.

The diagnosis is often difficult. In the absence of the characteristic fungus or the branches of its central mycelium, it must rest on the clinical findings. It may be difficult to distinguish from sarcoma or from syphilis. It may be stated here that iodide of potassium will often produce marked improvement in both actinomycosis and syphilis. Perhaps the most difficult condition to distinguish it from is the "ligneous phlegmon" of the neck.

Prognosis.—The prognosis depends on early recognition and prompt and energetic treatment. In neglected cases the disease may riddle the whole neck and fatal results are frequent.

Treatment.—The abscess cavities should be opened freely, and the pus evacuated. Afterward the dead tissues should be scraped away and the granulation tissue extensively removed with a sharp curette. Finally, the cavity should be disinfected with carbolic acid or chloride of zinc. The final result will depend entirely on the thorough curetting. Bevan speaks highly of the value of copper sulphate. He gives it internally in quarter-grain doses and irrigates the sinuses with a 1 per cent. solution.

Ligneous Abscess of the Neck.—(*Syn.: Phlegmon Ligneuse; Holzphlegmon*).—This disease, described by Reclus under the name "phlegmone ligneuse," is a very chronic inflammatory process attacking the lymphatic glands and resulting in a dense wood-like hardness of the deeper tissues of the neck. The cause of this disease varies greatly. Many different pyogenic organisms have been found and no one seems to be specific. It has been suggested that the disease is the result of an attenuated infection capable of producing and keeping up prolonged inflammation but incapable of producing pus.

Symptoms.—The source of the inflammation is found oftenest in the mouth and pharynx. It has followed mastoid disease. The submaxillary lymph nodes are usually first affected. They become swollen and indurated. There is not much pain. The periglandular tissues are next involved, the result being that all the subcutaneous tissues become fused into a hard board-like mass. The boundaries of the induration are often quite sharply defined from the non-infected tissue. There are practically no pain, tenderness or fever. There is little tendency to suppuration, but if an incision is made into the intermuscular spaces a purulent exudate may be found. The course of the disease is essentially chronic and it may remain stationary for long periods.

Diagnosis.—The diagnosis is very difficult. It may be mistaken for

lymphosarcoma, for secondary cancer or for actinomycosis. The first two can usually be eliminated by their rapidity of growth compared to the disease in question. A microscopic examination will clear up the case conclusively. From actinomycosis the diagnosis is less easy, especially so as it is occasionally a difficult matter to demonstrate the ray fungus in true cases of that disease.

Treatment.—As spontaneous cures have occurred in many of the reported cases and as active treatment appears to have had little to do with the results, it is probably better to treat the disease from a palliative standpoint. If evidences of softening and pus formation are present, free incisions should be made into the indurated areas.

LYMPHOSARCOMA AND HODGKIN'S DISEASE

Extreme types of these diseases differ from each other as light from darkness, but intermediate types approach one another so closely, in

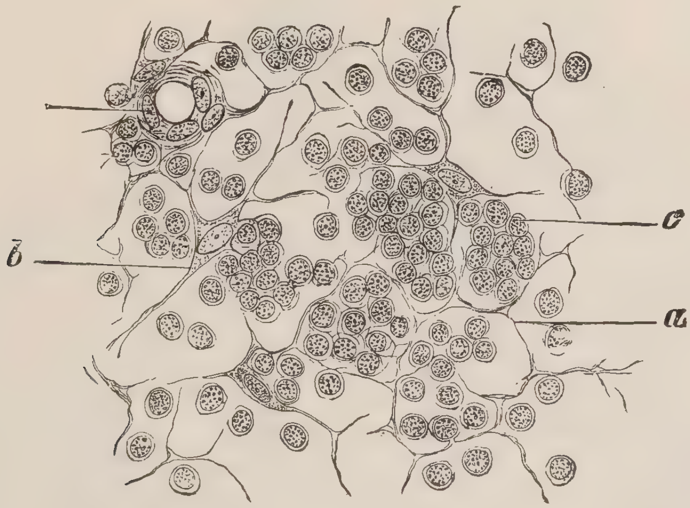

FIG. 169.—(*Lexer-Bevan.*)

their local manifestations and constitutional symptoms, that it is very difficult to draw a hard and fast boundary line.

Lymphosarcoma.—The *etiology* of this disease is as obscure as is that of all sarcomata. The upper substerno-mastoid group of glands is most often affected, but the disease is not infrequent in the parotid, the lower sterno-mastoid, and the supraclavicular groups. Histologically the growth is a round-celled sarcoma often of a pure type. The cells are very numerous and are contained in the spaces of a fine reticulum covered by endothelium (Fig. 169). There is no reproduction of lymphoid tissue. They usually occur in comparatively young patients, and are more common between the ages of 20 and 30. The

course of the disease is very characteristic. In the very early stages, one or two glands can be palpated as discrete enlargements. The glands grow with such unusual rapidity that in a few weeks they may double and treble their size. The glands soon lose their nodular and discrete appearance and fuse with one another and with the surrounding structures. The growth rapidly infiltrates the surrounding tissues, and flows around the great vessels and nerves of the neck embedding

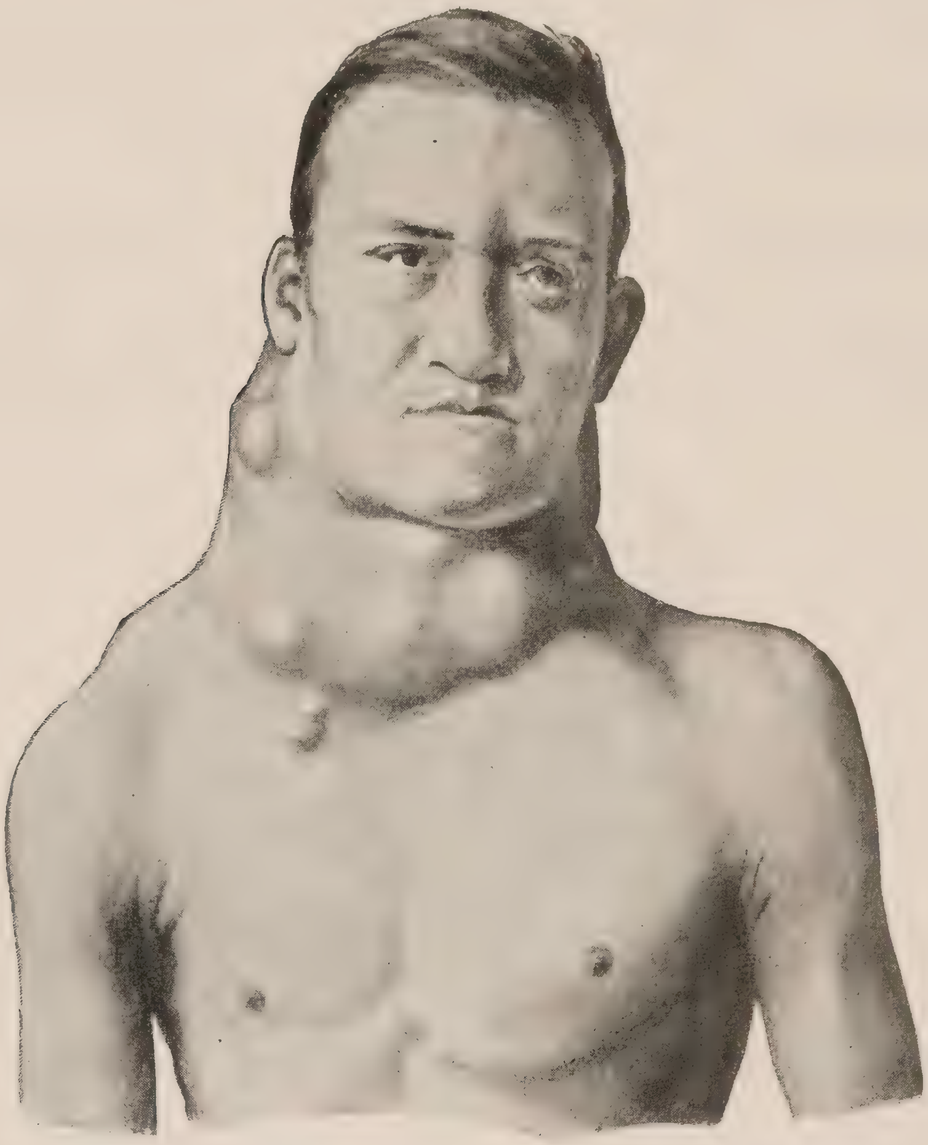

Fig. 170.—Lymphosarcoma of the neck. (*Lexer-Bevan.*)

them as if in a plaster cast. At the same time the walls of the blood-vessels may become infiltrated and portions of the growth may fungate into the lumen of the jugular vein. The muscles of the neck may be infiltrated and the growth may infiltrate and surround the walls of the trachea and larynx and the œsophagus and pharynx (Fig. 170). The growth has a great tendency to extend to the surface, and to infiltrate the skin. Fungation and sloughing result in the formation of enormous

craters which often bleed profusely. Some cases grow so rapidly as to infiltrate one side of the neck completely, and reach the stage of fungation in the course of three or four months. The writer has seen one case where death from exhaustion occurred within seven months of the time of its first appearance.

Symptoms.—In the early stages there are practically no symptoms other than the presence of the glandular tumor. Blood examination shows nothing characteristic. Later, pressure symptoms make their appearance. In the neck these mainly consist of interference with breathing from pressure on the trachea or larynx, or implication of the superior and recurrent laryngeal nerves. Dysphagia from pressure on the gullet is not uncommon in the later stages. Pressure on the carotid and internal jugular rarely gives rise to trouble, nor does implication of the vagus nerve affect the heart materially. As time passes the patient becomes weaker. At this period profound blood changes may be noticed. There is usually marked anæmia with decrease in the number of red blood-cells and lowered percentage of hemoglobin. The leucocyte count varies greatly. A leucocytosis of 10,000 or over is not uncommon. In the majority of cases it is not materially increased, and it may even be less than normal. In the later stages of the disease metastatic deposits may make their appearance in the internal organs, lungs, liver, spleen and even in the skin. At this stage, marked leucocytosis may make its appearance. The constitutional symptoms are usually not very characteristic. Apart from the anæmia and the symptoms that necessarily accompany it, such as loss of strength, intermittent fever and occasional hemorrhages, there is nothing characteristic. The fever, however, may show great variations. As a rule it seldom rises over 100° in the evenings, falling to normal in the mornings. Occasionally, however, severe rigors associated with a temperature of 102° to 104° may occur at intervals in a manner highly suggestive of septic absorption. Such chills are rather rare in lymphosarcoma of the neck but are common in retroperitoneal growths.

The *diagnosis* in the very early stages is almost impossible. It rests on the very rapid growth and early infiltration of the surrounding structures; on the tendency of the disease to implicate gland after gland, causing them to fuse together; and further on its tendency, in the lower part of the neck, to cross the middle line and implicate the glands on the opposite side.

The *prognosis* is very unfavorable. There is grave reason to believe

that we have no authentic record of a single recovery. Even after extensive and complete removal by operation, death usually occurs within a year from its first appearance.

Treatment.—Considering the uniformly fatal results it would appear that operative procedures should be condemned. Nevertheless, in cases that do not present insuperable anatomical difficulties, early and complete removal seems the only course to pursue. Local recurrences appear with unusual rapidity; in fact in a month or two after apparently complete removal, the recurrence may be as large as the original growth. Partial operations are worse than useless. The surgeon must be prepared to remove the carotid artery, jugular vein and pneumogastric nerve along with the tumor. It is needless to remark that such extensive procedures will be followed by a very high primary mortality. All other methods of treatment, such as the use of arsenic, Coley's fluid and the X-ray, are as powerless to affect the growth as they are in round-celled sarcomata growing in other situations.

Hodgkin's Disease (*Syn.: Malignant Lymphoma, Lymphadenoma, Aleukæmic Lymphoma*).—This disease is characterized by a progressive, painless enlargement of one or more groups of lymphatic glands associated with progressive anæmia which invariably terminates fatally. Classical types of this affection present a symptom-complex that is so characteristic that it can be separated sharply from both lymphosarcoma and lymphatic leukæmia. But many typical cases of slow, progressive glandular enlargement are met with which are attended by symptoms and blood pictures that make a clear distinction between these various affections very difficult and sometimes impossible.

Etiology.—The exact cause is unknown. The disease is more common in men than in women. It is a disease common to children and occurs more frequently between the ages of 10 and 20 than at any other period of life. The cervical group of lymphatic glands being more often infected than the other glands of the body lends some support to the theory that the poison enters the system through the tonsils and fauces. No uniform bacteriological findings have been discovered. Experimental inoculation of portions of glands into animals have resulted in nothing definite. The lymphatic enlargement which invariably follows is transitory and is a simple hyperplasia. The claims that have been advanced that the disease is merely an unusual form of generalized tuberculous infection is probably untenable.

Pathology.—The gross appearance of the glands is often very characteristic. One of the most common types is pictured in Fig. 171.

The tumor is found to consist of a large number of glands, the larger ones being in the center. Each gland is rounded and discrete, being

FIG. 171.—Hodgkin's disease. (*Keiller.*)

FIG. 172.—Hodgkin's disease. (*Keiller.*)

connected with its neighbors by lymphatic trunks which are quite conspicuous. They are firm and elastic to the feel and on palpation re-

semble potatoes in a sack. On section they are pink in color and firm in consistence. Each gland is surrounded by a definite capsule. The microscopic changes are usually very characteristic in the later stages. Coarse fibrous bands run from the capsule into the tumor, cutting it up into lobules. The reticulum is very thickened and the

FIG. 173.—Hodgkin's disease. (*Keiller.*)

cellular spaces are extremely narrowed. In the earlier stages, this tendency to coarsening of the reticulum is a marked feature, but the cellular spaces are large and are filled with a great variety of cells, viz.: lymphocytes, epithelioid cells, plasma cells, mast cells, and eosinophile leucocytes (Longcope).

In some instances the gross appearance of the glandular enlargements resembles that pictured in Fig. 172, in which the general outline of the mass suggests a collection of separate glands which have fused together. This condition is occasionally seen in the neck, and is very common where the glands are tightly packed as in the mediastinum.

In other instances the separate glands may fuse into a homogeneous rounded or oval mass, with a smooth surface surrounded by a definite capsule, which does not suggest its origin from a number of separate nodes. This is shown in Fig. 173, which represents a recurrence in the lower part of the neck after an operation for removal of a large number of discrete glands in the upper part of the neck.

Symptoms and Clinical Course.—The first symptom noticed is the glandular swelling, which may appear in the neck, axilla or rarely in the groin (Fig. 174). Anæmia and loss of strength appear later. The cervical group is affected most frequently. The enlargement is slow and painless and each gland is usually separate from the others. The rate of growth is usually steady, but occasionally we meet with cases in which the glands remain stationary for variable periods. The rapidity of growth shows great variability. In some cases the glands grow with startling rapidity, while in others the rate of growth is extremely slow. In many instances periods of rapid growth may alternate with periods of slow growth. As a rule, the extension of the disease is in the direction of the lymphatic flow, as from the inguinal to the iliac and lumbar glands. As the glands enlarge they may produce pressure symptoms. In the neck dyspnœa from pressure on the trachea is the most distressing. Dysphagia is not uncommon. Pressure on the veins may produce cyanosis and œdema. (Mediastinal and abdominal symptoms are described elsewhere.) The constitutional symptoms consist of the following: fever; progressive anæmia; and the presence of lymphoid masses in the skin, the liver and spleen producing enlargement of these organs. Fever is fairly constant. It varies in type but is usually intermittent. A relapsing type of fever has been noticed. Anæmia becomes marked. The count of red blood corpuscles may fall as low as 2,000,000, and the percentage of hemoglobin to 30 or 40. The white blood count is not characteristic. There is often a slight increase, but it rarely rises higher than 20,000. The picture never resembles that of lymphatic leukæmia owing to the low percentage of lymphocytes. During the course of the disease both spleen and liver may show marked enlargement. Both these organs are usually the seat of lymphomatous nodules which have been described as metastatic tumors. As similar lymphomatous nodules are occasionally found in the kidney, lung, pericardium and pleura, etc., they are probably not metastatic tumors but merely overgrowths of normal lymphoid tissue.

Diagnosis.—In the early stages of the affection accurate diagnosis of Hodgkin's disease is usually an impossibility. Without the aid of a

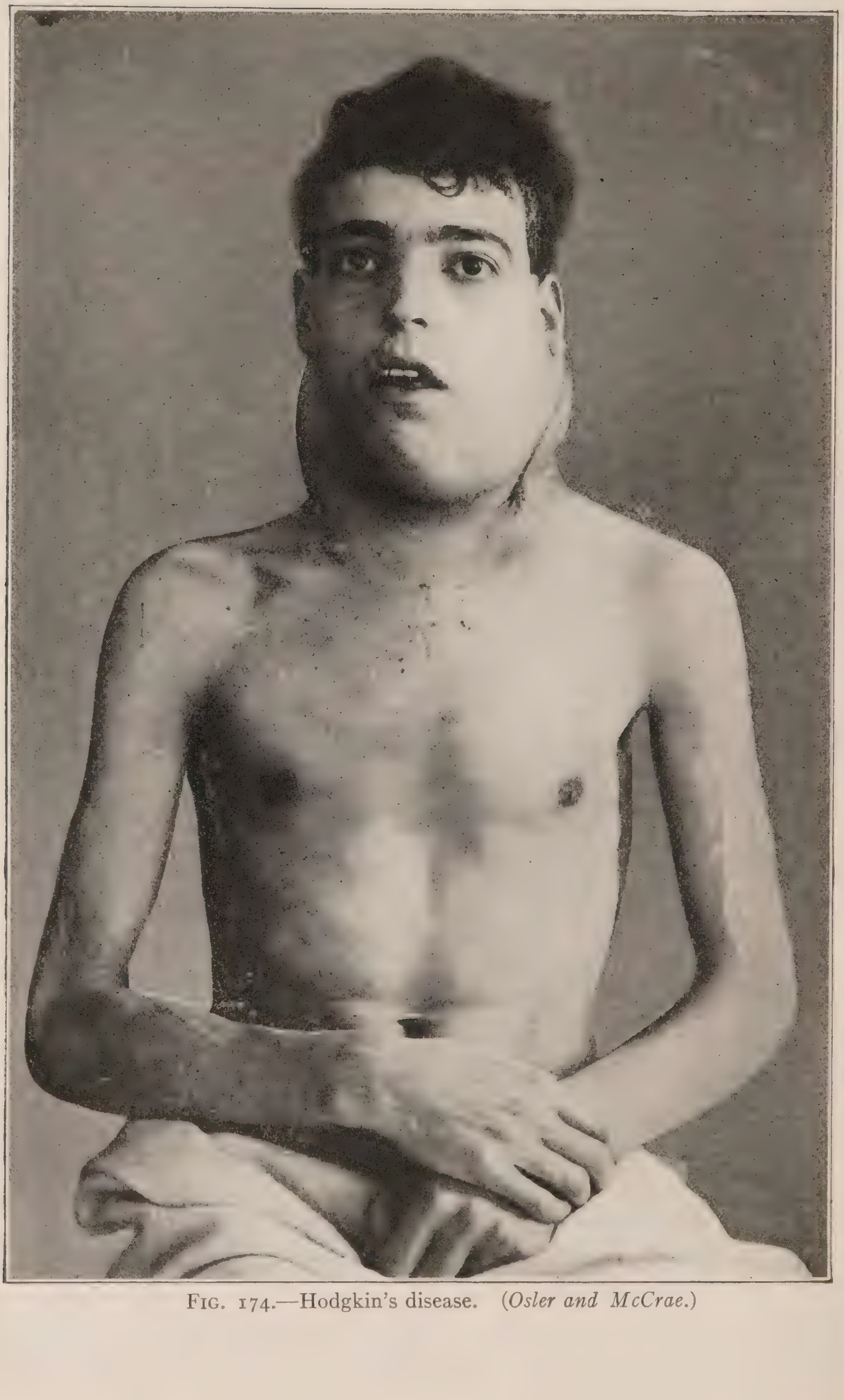

FIG. 174.—Hodgkin's disease. (*Osler and McCrae.*)

microscopic specimen of one of the affected glands, it is impossible to distinguish it from lymphosarcoma, tuberculosis and inflammatory hyperplasia. In the later stages the splenic enlargement, the character of the glandular enlargement, its slow, indolent, progressive growth and the progressive anæmia are usually characteristic of Hodgkin's disease. The presence of enlarged lymph nodes, in addition to the splenic enlargement, distinguishes it from splenic anæmia. In lymphatic leukæmia we usually have marked glandular enlargement and an enormous spleen. Blood examinations revealing very high leucocyte counts (50,000 to 100,000) with a large percentage of lymphocytes usually settle any doubts. In lymphosarcomata, the extremely rapid growth of the tumors with their tendency to infiltrate the surrounding tissues and to fungate through the skin are very characteristic. From some types of tuberculous glandular enlargements the diagnosis is very difficult. Longcope has called particular attention to the similarity in the physical signs between either one or two types of tuberculosis of glands and Hodgkin's disease. One type, an acute form of tuberculosis, is apt to arise in the cervical glands. One or both sides of the neck may be involved, and the glands increase in size rapidly. The glands are oval, elastic, discrete and painful. There may be intermittent fever. The resemblance to Hodgkin's disease may be perfect. The other type is the generalized caseous variety. Separate groups of glands in various parts of the body may be enlarged. Some of the glands are discrete, others are fused together. Occasionally, the true nature of the disease may be indicated by a gland caseating and breaking down or by the discovery of a healed sinus. There is often fever and anæmia. A case of this nature was recently seen by the writer. A woman aged 28 came under observation showing marked enlargement of the glands of both sides of the neck, both axillæ and both groins. The spleen was appreciably enlarged. There was marked anæmia but no leucocytosis. After long treatment by arsenic, with no improvement, a cervical gland was removed for microscopic examination and proved to be tuberculous. It is probable that many cases of this nature have lent support to the theory that Hodgkin's disease is a tuberculous manifestation.

There are some malignant growths which arise in the lymph nodes that have certain features resembling lymphosarcomata and others resembling Hodgkin's disease. Paltauf and Sternberg drew distinctions between sarcomata arising in lymph-glands and lymphosarcomata. MacCallum has also emphasized this point. Longcope has pointed out that some of the sarcomata of the lymph nodes may grow more slowly

than usual and form large irregular masses in the neck and axilla. The enlargement may be painless and accompanied by fever and anæmia. Clinically they resemble Hodgkin's disease very closely. Microscopically, they consist of round cells, often larger than lymphocytes and of a variable amount of interstitial tissue. The exact position that these tumors occupy in the lymphatic enlargements is hard to decide. Some of them resemble lymphosarcoma and others resemble Hodgkin's disease. Those that have occurred in the writer's experience have given rise to considerable uncertainty as to their exact nature. One case occurred in a boy aged 13 years, and the history pointed to the existence of five or six discrete glandular enlargements in the upper cervical region, which were removed six months before he came under my care. A diagnosis of Hodgkin's disease had been made. On examination, a large tumor was found occupying the left side of the neck, extending from just below the mastoid process to the level of the sternoclavicular joint where it projected under the clavicle. This tumor was nodular, circumscribed and fairly movable. It was excised and with it segments of the internal jugular vein and sympathetic nerve (see Fig. 173). In the upper part of the neck the removal was not quite thorough. Arsenic was given for a year after the operation, during which time there was no sign of recurrence. Arsenic was then discontinued and recurrence appeared in less than a month in the occipital region. Arsenic was resumed and the growth remained stationary for six months. It was again discontinued and the growth increased so rapidly that arsenic lost control and the patient died. Another case of similar nature had an interval of five years between the first operation for the removal of the sarcomatous glands in the upper (parotid) region of the neck and the second operation for the removal of a recurrence in the lower glands of the deep cervical chain. After the second operation, which consisted of a clean removal of an oval, glandular mass along with the internal jugular vein, two years of freedom from recurrence followed. The second recurrence proved fatal from infiltration of both sides of the neck. A pathological diagnosis of round-celled sarcoma was made in both these cases. A third case was a slowly growing sarcoma of the glands of the left axilla. The type was round-celled, with very large mononucleated cells. There was an interval of two years between the first excision and the first recurrence. The second operation was imperfect and was followed in a week by an interscapulothoracic amputation. Recurrence of the growth showed itself in the scar at the end of three months. This disappeared completely under the influence of the X-ray, before the patient left hospital.

In all these cases certain characteristics have stood out in strong relief: (1) their great clinical resemblance to Hodgkin's disease in the early stages; (2) the certainty of recurrence sooner or later after operation; (3) their tendency to become more malignant after each removal; (4) their susceptibility to the therapeutic effects of arsenic and the X-ray.

Prognosis.—Sooner or later every case of Hodgkin's disease has a fatal termination. Many cases improve or remain stationary for variable periods of time under suitable treatment, but a time arrives inevitably when the disease progresses steadily to a fatal end. The cause of death is cachexia, or some complication, of which tuberculosis is by far the commonest.

Treatment.—Although a permanent cure of Hodgkin's disease has probably never been seen, great improvement will often result from medicinal treatment. Arsenic is the most valuable drug we can employ and it should be pushed to the utmost tolerance of the patient. It may be given by mouth as Fowler's solution, or hypodermically, or even intravenously as salvarsan. The immediate effect produced by X-rays is remarkable. The glands shrink and often disappear entirely, but reappear as soon as treatment is discontinued. Operative measures have not proved succsesful. Invariably, either a local recurrence follows or glands in another region become affected. The true value of operative measures has never been accurately estimated. There is no doubt, as mentioned previously, that partial removal of the glandular swelling renders the portion left behind more susceptible to the influence of arsenic. Therefore it seems rational to remove all glands surgically accessible and to treat vigorously with arsenic and X-rays those left behind. This practice has been followed by the writer for many years with happy results as regards prolongation of life.

ADDENDUM TO HODGKIN'S DISEASE

In 1910 Fraenkel and Much (Zeitsch. f. Hyg., 1910, LXVII, 159) found present in the nodes of Hodgkin's disease a Gram-staining, but non-acid-fast, tubercle bacillus or a bacillus related to it quite closely. Recently, Negri and Mieremet (Centralblatt für bakteriol., 1913, LXVIII, 292) and Bunting and Yates (Archives of Internat. Medicine, Aug., 1913) have cultivated from a number of cases of Hodgkin's disease an organism that is probably identical with that described by Fraenkel and Much, and which may probably be proven to be the actual cause of the disease. The organism is a diphtheroid bacillus, non-acid-fast and Gram-staining, which grows luxuriantly at the body temperature. It is a

facultative microbe which shows great variability of form. To it Negri and Mieremet have given the name of "Corynebacterium granulomatosis maligni," while Bunting and Yates have suggested the name "Corynebacterium Hodgkini."

Inoculation experiments on the monkey (*Macacus Rhesus*) by Bunting and Yates (Journ. Amer. Med. Assn., Nov. 15, 1913) have resulted in changes practically identical with those found in the glands in Hodgkin's disease. Finally, Billings and Rosenow (Journ. Amer. Med. Assn., Dec. 13, 1913) have corroborated the observations of previous workers and have treated seven patients suffering from Hodgkin's disease by injections of autogenous vaccines prepared from pure cultures of the organism. In six of the patients there was marked improvement, the lymph nodes decreasing in size rapidly and uniformly. One of these received no Röntgen treatment; two died, but both had marked mediastinal involvement. One patient is apparently well. The rest of the patients appear to be improving with varying degrees of rapidity. It is, of course, premature to speak otherwise than in a general manner as to the true value of this method of treatment.

INJURIES OF THE NECK

Injuries of the neck may be conveniently divided into two classes:

1. Contusions, usually produced by a blow from a blunt instrument or by throttling or hanging.

2. Open wounds produced by sharp instruments or by bullets.

Contusions of the Neck.—Apart from injury to the hyoid bone, laryngeal (see elsewhere) cartilages and the trachea, symptoms following contusions are insignificant. The laceration of the subcutaneous tissues usually affects the small blood-vessels and the resulting extravasation is small in amount and is rapidly absorbed. Rupture of the large blood-vessels is so rare as to be almost negligible. Where a contusion is followed by marked swelling and is accompanied by dyspnœa, the symptoms point strongly to a coincident injury of the box of the larynx or trachea, a condition of the gravest danger to the patient unless relieved.

Open Wounds.—These may be accidental in nature, such as stabs or bullet wounds, or they may be clean wounds made by the surgeon during operations on the neck for the removal of tumors, etc. In accidental wounds the structures are sometimes divided in a cleanly manner, but where the instrument is blunt, as the end of an umbrella or in bullet wounds, severe laceration may result. It will facilitate the consideration of this subject to consider the wounds of the important structures seriatim.

Wounds of Arteries.—Suicidal wounds of the large arteries of the neck are comparatively rare, owing to the fact that the patient usually expends the energy of the cut against the resisting thyroid cartilage which projects forward and shelters the large vessels from injury. Stabs often result in a clean wound and if the artery is completely divided the two ends may retract, curl up and become thrombosed, the bleeding being permanently arrested. If the wounded artery is a large one, such as the common or internal carotid, death from hemorrhage usually results promptly. If, however, only part of the circumference of the artery is wounded and death does not result from primary hemorrhage, bleeding may cease when the blood pressure has been reduced to a low level from the loss of blood. The opening in the artery fills with clot which may adhere firmly, in which event there will be no recurrence of the bleeding; or, the clot may be poorly formed and easily detached, the result being a secondary hemorrhage; or, the clot may be defective and incapable of closing the mouth of the vessels firmly, a state almost invariably followed by the formation of an aneurism. Injuries of arteries by bullets are not always followed by the classical symptoms of hemorrhage. Small caliber, high velocity bullets, are capable of cutting clean punched wounds in the sides of arteries which may be followed by immediate, severe and fatal bleeding. A large proportion of sudden deaths on modern battlefields result from arterial hemorrhage. Low-velocity large-caliber bullets may divide an artery and the ends may be so contused that they curl up and become thrombosed at once, practically no bleeding occurring; or, on the other hand, they often bruise the arterial walls so severely that part or the whole circumference dies, circulation ceases and clotting occurs. If the clot remains aseptic, bleeding will never be seen, but if sepsis occurs the clot may be detached and secondary hemorrhage may result.

Symptoms and Diagnosis.—Hemorrhage is, of course, the only certain sign of a wound of an artery. In many instances this can only be ascertained from the history, bleeding having ceased soon after the accident. A dry wound at the time of observation must not lead us to the conclusion that the artery is not wounded. As soon as the blood pressure rises, bleeding will probably recur. If there is a history of a severe bright-red hemorrhage, it is safer to assume that an important vessel has been wounded. The history of many fatal cases is clear, viz., a severe primary hemorrhage caused by the injury, followed by a number of recurrent hemorrhages at intervals until the patient succumbs. In certain conditions, symptoms such as absence of pulse in

the periphery or evidences of cerebral anæmia may indicate a complete division of the vessel. Wahl's sign, *i.e.*, a systolic murmur over the point of injury, is not an absolutely reliable sign of partial division, of a vessel.

Treatment.—If the case is seen while active hemorrhage is present an attempt should be made to find the bleeding vessel and close the opening, either by ligature or by suture. The patients are rarely in surroundings that justify such courageous surgery and usually the wound is plugged or pressure applied with temporary arrest of the bleeding. The further conduct of the case will depend on many factors: (1) length of time that has elapsed since the accident; (2) the situation of the wounded vessel; (3) the condition of the wound. If the wound is recent, immediate operation should be contemplated if the environments are suitable and the wounded vessel is accessible. If several days have elapsed since the infliction of the wound it is better to wait until infection has subsided. If, however, the wound has been packed with gauze the case is more complicated. Infection is inevitable sooner or later, and we can choose between the risks of immediate hemorrhage if the gauze is removed at once and secondary hemorrhage if the operation is delayed. The choice is difficult and will often be decided by the condition of the patient, as to loss of blood, etc. Wounds of arteries in difficult or inaccessible situations must always be treated primarily by expectant methods such as pressure and packing. Later on, if the condition of the patient warrants the procedure, an attempt may be made, by direct attack or proximal or distal ligature, to control the bleeding permanently. From experience acquired in recent wars military surgeons have emphasized the necessity of non-interference with arterial and arterio-venous wounds unless associated with open or concealed active hemorrhage. Delay is advised until the injured tissues have recovered from injury and infection. Under appropriate treatment, such as occlusion of the wound and absolute rest, further bleeding will usually stop and consolidation of the wound result. Of course, in a large number of cases an aneurism will appear, but as time passes the collateral circulation will develop and in a few months operation can be performed with much less risk. These late operations are much easier from an anatomical standpoint because all the structures can be recognized and protected, and likewise conservative operations can be practised whereby the blood-vessels can be saved. Cerebral anæmia is much less common after late than after early operations on the carotid; while in wounds of the peripheral vessels late operations reduce the dangers of gangrene to a minimum.

Wounds of Veins.—Veins, like arteries, may be wounded by stabs, bullets, penetrating foreign bodies and subcutaneous contusions. In accidental wounds, such as stabs, the vein and artery may be opened simultaneously and if the patient recover, one or other variety of arterio-venous aneurism may result.

Symptoms and Diagnosis.—If the blood is venous in character and escapes from the wound in a regular stream and not in intermittent jets, the wounded vessel is probably a vein. The evidence is not absolute, however, especially in a wound that has been inflicted for some time. One often sees blood of a dark venous color trickling from a wound in the neck where operation reveals a wounded artery only. Bleeding from injuries of so large a vein as the internal jugular is so rapid and profuse that patients die very rapidly. If efficient aid is not available soon after the accident, the mortality is higher even than in wounds of the large arteries. During operations on the neck a wound of the jugular may result in the loss of a prodigious amount of blood in a very short time.

Treatment.—The only rational treatment is direct closure of the wound in the vein. The wound in the neck should be enlarged and pressure applied on the bleeding point by the assistant's finger. The vein should be exposed and the opening firmly closed. This may necessitate ligature of the vein above and below the opening. In other cases part of the wall of the vein may be pinched up and ligatured. In still other cases the opening may be carefully sutured. Where the vein is inaccessible as in wounds of the jugular at the root of the neck or near the base of the skull, we must rely on pressure from careful packing. This will often be successful. The application of clamps is very unsatisfactory and must only be used as last resort.

Entrance of Air into Veins.—In the older writings on surgery, great importance was given to this accident, which seems to have been of fairly frequent occurrence during operations for the removal of tumors. At the present time it seems to be rare, owing probably to smoother anæsthesias, to the position of the patient while operating and to a greater anatomical and technical nicety in conducting the operations. It must, however, be still considered as a real danger. Green, writing in 1864, collected sixty-four cases with an immediate mortality of twenty-four. During the removal of tumors the accident is more likely to occur when the tumor has been separated from all its connections except the deep ones. If strong traction is made and the vein torn or opened, air is sucked into the vein with a hissing noise, breathing

becomes embarrassed and the patient may die in a few minutes. Almost invariably the accident happens after wounds of the internal jugular and if care is taken early in the operation to secure this vessel and control or obliterate it temporarily, the accident can be prevented. If the accident has occurred and some air has been sucked in already, the wound should be flooded immediately with water to prevent more air from entering. If serious symptoms result from the air that has gained entrance, cardiac stimulants and artificial respiration should be employed.

Wounds of the Thoracic Duct.—Wounds of this duct may be divided into two classes: (1) accidental wounds, (2) wounds occurring during operations for the removal of tumors.

Accidental wounds are not common, and owing to the deep position of the duct and its close relationships with the internal jugular vein, the subclavian and vertebral veins,. uncomplicated wounds are almost impossible. Zesas collected twenty-four cases, caused by bullets, stabs, and fractures, etc. In seventeen of them chylothorax occurred; in one, chylous ascites; and in one, both complications. One-half of these patients died. It will be seen from the above data that these complicated wounds are very serious. Wounds of the duct occurring during the removal of tumors are probably fairly common. The writer has met with three instances, all of which terminated favorably. Yet Zesas was able to collect 58 cases only. As a rule, the accident is recognized by the escape of chyle as soon as the duct is divided. In other cases no flow occurs immediately, but the wound fills with chyle which is discovered later. The resulting discharge in some cases has been enormous in quantity. It was more or less continuous, but increased in quantity during digestion. In the majority of cases the discharge ceased spontaneously, but in some instances a permanent fistula resulted. That the accident is attended with some risk is shown by the fact that five deaths occurred out of 55 collected cases (Frèdet). The cause of death was exhaustion.

Treatment.—Accidental wounds are best treated by the expectant plan, the complications such as chylothorax being dealt with as they arise. When the duct is wounded during an operation, and the accident is recognized, the proximal end should be closed with a ligature. Wounds discovered later may be treated either by tampons or the neck may be reopened and search made for the severed duct. Tamponade has not, however, been followed by much success. Wherever feasible, the duct should be isolated and carefully ligatured. Suture

of the duct has been advised. In one case Deanesley isolated the proximal end of the duct and implanted it successfully into the jugular vein. After ligature the flow of chyle usually ceases and no serious results follow. In all probability the flow of chyle is diverted into the right thoracic duct which is often well developed, or passes into the venous circulation through very constant anastomoses between the left thoracic duct and branches of the azygos and left renal veins.

INJURIES TO NERVES

Every nerve in the neck is liable to be injured by stabs or bullet wounds. In many instances large blood-vessels are wounded at the same time and the nerve lesion is overlooked.

Hypoglossal Nerve.—Except during the course of operations this nerve is seldom injured. Cases of division have been reported after stabs and gunshot wounds. The symptoms are very characteristic. One-half of the tongue is completely paralyzed. On inspection the tongue is pushed bodily toward the paralyzed side. The sound edge is convex and the paralyzed edge is straight or concave. The median raphé is concave toward the paralyzed side. During mastication the tongue gets between the teeth. Speech is thick and slurred. If the tongue is protruded between the teeth, it points toward the paralyzed side. In the course of time hemiatrophy of the tongue will follow division, but the patient regains sufficient control over the tongue to avoid biting it and learns to speak clearly.

Treatment.—If the accident is recognized during the course of an operation, the divided ends of the nerve should be sutured together. Also after division by accidental wounds the ends of the nerve should be exposed and united.

Glossopharyngeal Nerve.—While isolated injuries to this nerve must have occurred, they have not been recorded. During extensive operations the nerve has been frequently divided. The symptoms produced are loss of sensibility in the posterior third of the tongue and in the side of the pharynx, and difficulty in swallowing from paralysis of the middle constrictor and stylopharyngeus muscle (Sherren).

The Pneumogastric Nerve.—The symptoms following division of this nerve during the course of an operation vary within great limits. In some cases serious symptoms come on immediately, such as rapid heart beat and slow respiration. In others, a fatal result has occurred. In the course of an operation, symptoms of a serious nature are much more likely to be seen if the vagus is irritated by being dragged on or

lacerated while trying to dissect it away from a tumor, than if the nerve is boldly divided at once and sheltered from injury (Pilcher). The writer has divided this nerve six times during the course of operations and has never seen serious results follow. In two of the cases no difference was noted in the pulse at the time of operation or during convalescence. In four, the pulse became slightly more rapid, and during convalescence the rate of beats varied from 15 to 30 more than normal, being greatly increased during excitement. In every case there was paralysis of the recurrent laryngeals. The high mortality of 52 per cent. given by von Bergmann must be attributed to the serious nature of his cases which necessitated removal of important structures such as the common carotids. It may be safely stated that division of one vagus nervc is not to be looked upon as a dangerous procedure.

Treatment.—If the accident is recognized, an attempt should be made to unite the divided ends of the nerve to aid restoration of function to the paralyzed laryngeal muscles. Even in cases where no attempt has been made to obtain union and instances where a considerable segment of nerve has been removed, in the course of time the patient regains control of his voice to a remarkable extent. A case under the writer's care showed for years a mild degree of tachycardia and hoarseness. At the end of 10 years the voice was almost normal and the tachycardia had disappeared. Shelton Horsley has reported a case of secondary suture of the recurrent larnygeal nerve after division during a goiter operation.

Sympathetic Nerve.—Except during operations, injuries to the main sympathetic trunk alone are very rare. Most wounds of the neck that are likely to wound the sympathetic also wound important vessels and other nerves. It has been wounded by stabs in the lower portion of the neck. Some of its communicating fibers are often torn in injuries of the lower cervical region of the spinal cord and in traction injuries of the lower cords of the brachial plexus (lower arm type). Division in the neck produces characteristic eye symptoms. The palpebral fissure is narrowed owing to a pseudo-ptosis, *i.e.*, the upper lip droops but is not paralyzed. There is enophthalmos. The pupil is usually slightly contracted. The affected side of the face is colder than the sound side and does not flush or sweat. Absence of sweating is noticed in the upper extremity of the same side (Sherren). The heart is apparently not affected. Irritation of the sympathetic caused by the pressure of tumors produces the opposite of these symptoms, viz., widening of the palpebral

fissure, exophthalmos, dilatation of the pupils, flushing and sweating of the area of skin controlled by it. No serious results follow removal of a segment of this nerve during operations. As a therapeutic procedure the various sympathetic ganglia of the neck have been removed to cure epilepsy and glaucoma (Jonnesco).

Spinal Accessory Nerve.—This nerve is occasionally wounded accidentally. Far more frequently it is divided during the course of operations for the removal of tumors. Division of the nerve is employed as a deliberate procedure for the relief of spasmodic torticollis. If divided in the anterior triangle, almost complete paralysis of the sterno-mastoid and paralysis of the upper portion of the trapezius result. (The sterno-mastoid probably receives a few fibers from the second cervical nerve, while the lower portion of the trapezius is well supplied from the third and fourth cervical nerves.) Paralysis of the sterno-mastoid does not seem to interfere materially with the movements of the neck, although its wasting may cause slight deformity. Paralysis of the upper portion of the trapezius is hardly noticeable, except for a slight wasting and slight drooping of the shoulder. If, however, as may easily occur in extensive operations on the lymphatic glands, both spinal accessory and the branches of the third and fourth cervical are divided, marked deformity results. The trapezius shrinks and the neck wastes, the shoulder droops markedly, and the scapula rotates forward. Viewed from behind, the vertebral border and lower angle of the scapula are more prominent (winged scapula). The movements of the arm are seriously interfered with. When abducted outward at right angles to the body the arm cannot be raised above the head (Sherren).

Treatment.—The greatest care should be taken during operations to preserve the spinal accessory from injury. If division is unavoidable, the divided ends should be sutured.

Cervical Plexus.—Injuries to branches of this plexus are more common during extensive operations than as the result of accidental wounds. While removing large glandular tumors from the posterior triangle, they are often unavoidably wounded. As the most vulnerable nerves are sensory branches, very little harm is done, at least permanently, for the anæsthesia that follows their division soon disappears. The sensory nerves derived from the cervical plexus may be divided into two sets, an ascending and descending set. The ascending branches arise from the loop between the second and third nerves and are respectively the transverse cervical, the great auricular and the small occipital.

They arise in a bunch and diverge to their destinations from a point on the posterior edge of the sterno-mastoid near its middle. Here they can be exposed and cocainized. The descending set arise from the loop

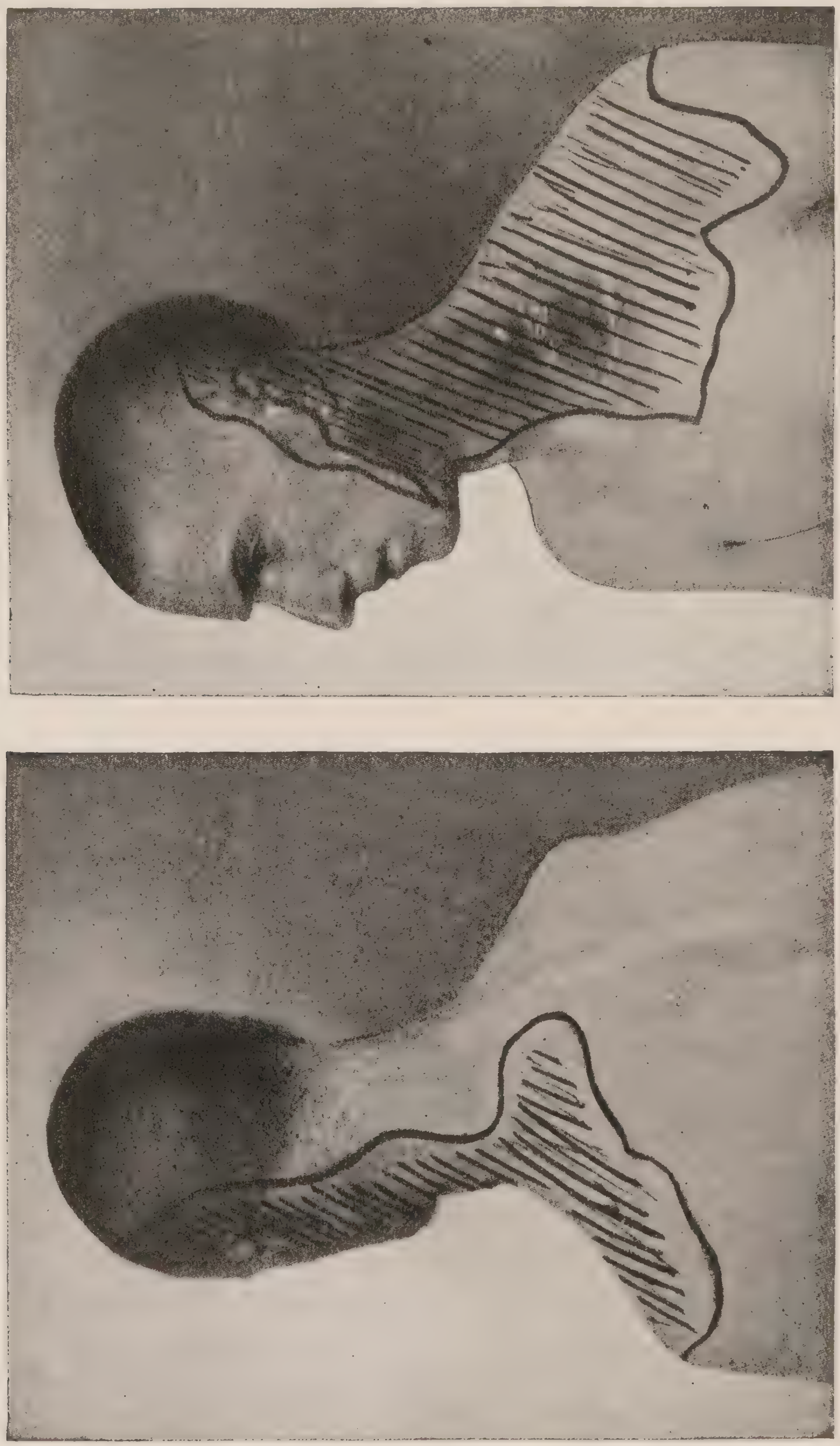

FIG. 175.—Loss of sensibility after section sensory nerves of the cervical plexus. (*Sherren. Modified from Cushing.*)

between the third and fourth nerves and pass downward over the sternum (sternal), clavicle (clavicular) and acromion (acromial). As these nerves probably assist the facial nerves in the supply of the platysma and

arise from the same roots that supply the trapezius, they supply the skin area over the whole extent of these muscles. Fig. 175 borrowed from Sherren illustrates clearly the area of anæsthesia and is a beautiful illustration of Hilton's law.

Phrenic Nerve.—This nerve arises mainly from the anterior branch of the fourth cervical nerve, and receives fairly constant accessory branches from the third and fifth. The main trunk lies on the anterior surface of the scalenus-anticus muscle to which it is closely applied in the whole of its course down the neck. Accidental wounds of this nerve are very rare. During operations, especially for the removal of tumors from or ligature of arteries in the lower part of the neck, the nerve is in some danger, but owing to its intimate relation with the scalenus-anticus and its comparative remoteness from the lymphatic glands it usually escapes damage. It is the experience of the writer that it is one of the structures most easily avoided in the surgery of the lower neck. Schroeder and Green in 1902 reported a case of division of the phrenic while removing a fibroma of the neck. The nerve ends were sutured immediately. The respirations increased in frequency (32 per minute) and remained frequent for a few days. The patient had no difficulty in breathing and recovered without further symptoms. They reported five other cases all of which were fatal. It is probable that the cases reported up to this time were notun complicated, but that other vital structures had been injured. There seems to be no reason, either from an anatomical or physiological standpoint, why any serious results should follow the division of one phrenic nerve. Paralysis of one-half of the diaphragm follows, but the intercostal muscles are fully capable of carrying on respiration on the affected side. Pulmonary trouble may occur. In one case reported by Erichsen and Riedel, death occurred from pneumonia.

Treatment.—Immediate suture should be employed in all cases of division of this nerve during an operation. In cases of accidental injury the operation may be undertaken in uncomplicated cases.

Injuries of the Brachial Plexus.—The brachial plexus is formed by the union of the anterior primary divisions of the fifth, sixth, seventh and eighth cervical nerves and the first dorsal nerve (Fig. 176). Before union these nerves can be seen as separate trunks lying between the scalenus-anticus and scalenus-medius muscles. In subjects with very sloping shoulders and correspondingly low clavicles, all the roots may lie in the neck above the level of the clavicle. In an average person the lowest two cords are usually below this level. Stabs above the clavicle

may wound any of the roots. Wounds of the eighth cervical and first dorsal roots are usually attended with serious injury to the third part of the subclavian artery, which lies in front of them. We possess at the present time a fairly accurate knowledge of the distribution of the motor roots which has been acquired from the study of clinical cases after nerve division and from stimulation of the roots during

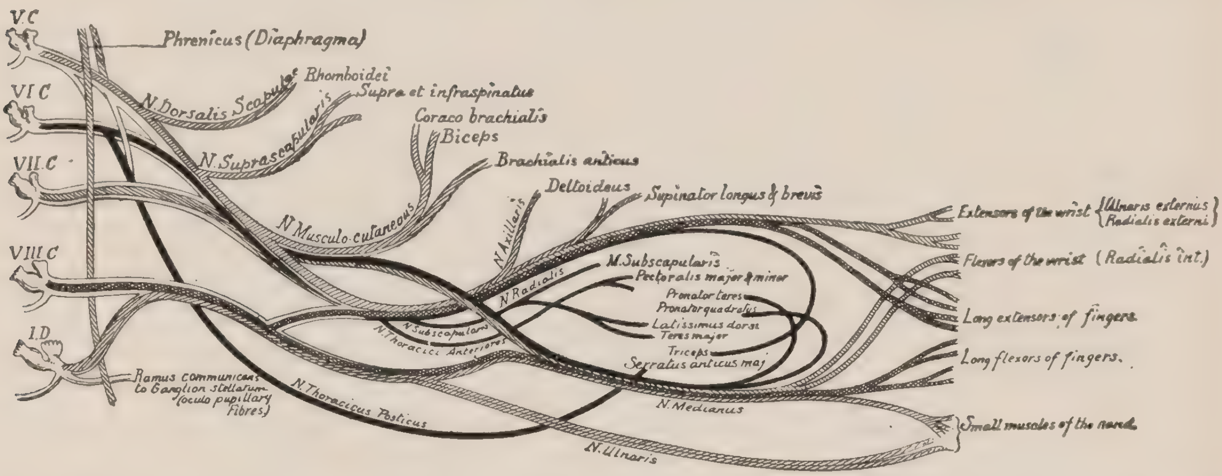

FIG. 176.—Semidiagrammatic scheme to show the formation of the brachial plexus and the nerve-supply to the muscles of the upper extremity. (*Kocher, Keen's Surg.*)

operative procedures; but our knowledge of the sensory distribution of these roots is very imperfect.

The sensory distribution seems to vary within great limits, owing mainly to the overlapping of the sensory fibers from contiguous roots. Apart from the apparent irregularity caused by imperfect methods of testing between protopathic and epicritic sensibility there is a real irregularity due to the overlapping, varying in extent in different individuals. Thus there is the greatest divergence of symptoms. In one individual division of, say the fifth and sixth roots, may be unattended by any sensory symptoms, whereas in another, areas of anæsthesia are found. The appearance or absence of anæsthesia after division depends entirely on the degree of overlap of the sensory fibers in the adjacent roots. In cases where definite areas of loss of sensibility appear, their extent seems to correspond with the full protopathic supply of the severed nerves. Division of the posterior roots of the spinal nerves also cuts off the nerves presiding over protopathic sensibility and we find that the area of loss of protopathic sensibility is larger than that of epicritic. We also find in the cervical and to a less extent in the other regions of the cord great overlapping of the areas of sensory supply. As a rule, division of three successive roots will produce some area of anæsthesia but in some cases a greater number

can be divided without sensation or the reflexes being affected. Binnie quotes Taylor as having "in one case divided six successive roots from the twelfth dorsal to the fifth lumbar inclusive, on one side, with full retention of sensation."

The motor distribution of the upper and lower roots has been fairly accurately worked out, but that of the middle roots less accurately, owing to the comparative infrequency of injuries of the latter. The following table, taken from Sherren, which differs in a few unimportant particulars from those of Thorburn and others, is a résumé of our present knowledge of this distribution to the muscles of the upper extremity.

Fifth Cervical.—Deltoid, biceps, brachialis, anticus, supinators, rhomboids, usually the spinati, occasionally the radial extensors of the wrist, rarely the pronator radii teres.

Sixth Cervical.—Pronators, radial extensors of the wrist, clavicular portion of pectoralis major, serratus magnus.

Seventh Cervical.—Triceps, extensor carpi ulnaris, extensors of the fingers, pectoralis major.

Eighth Cervical.—Flexors of the wrist, flexors of the fingers.

First Dorsal.—Intrinsic muscles of the hand.

Damage may be inflicted on the brachial plexus and its component parts in one of two ways:

1. The injury may be isolated, *i.e.*, it may be inflicted by a pointed instrument, such as a knife or by a bullet, and produce a localized injury such as contusion or division of a root entering the plexus or some component part of the plexus.

2. The injury may be more diffuse, *i.e.*, it may be produced by traction on the nerves caused by a direct pull on the arm when the neck is fixed, or a pull on the neck when the arm is fixed.

Isolated injuries may sever one or two cords and produce definite types of paralysis. The writer has seen a typical Erb-Duchenne paralysis result from division of the fifth cervical root from a bullet; and also the lower-arm type of paralysis result from a stab which severed the root of the first dorsal nerve.

In bullet wounds the conductivity of the nerve is often permanently destroyed even when the trunk is merely contused and not divided. In a large number of cases of mere contusion motor power is regained to a certain degree with the lapse of time. The diagnosis between contusion followed by temporary loss of conductivity only and complete destruction of the conducting fibers can only be arrived at after the lapse

of a week or two. The paralyzed muscles should be tested frequently at intervals of a few days for the reaction of degeneration. If this appears, which it may do as early as the end of the second or third week, it is evidence of complete destruction of the conducting fibers and operation should not be delayed. If, however, the reaction of degeneration does not appear, the chances are that regeneration will result in time and that the return of function in the paralyzed muscles will be assured, to a fair extent at least.

In a case under the care of the writer, the patient had been shot in the neck four months previously. Paralysis of the shoulder followed immediately. There had been slight gradual improvement in the use of the shoulder since the accident. There was no anæsthesia. The deltoid, biceps, supinators and brachialis anticus were paralyzed and wasted. There was sluggish response to both the faradic and galvanic currents but no reaction of degeneration. Operation revealed complete division of the fifth cervical nerve root just at its junction with the sixth, also evidences of destruction of part of the sixth root. The scar tissue was removed and the proximal end of the fifth root sutured into a slit made into the upper side of the junction of the fifth and sixth roots. The patient remained under our care for six weeks and during that time did not show any improvement.

In another case of division of the root of the first dorsal nerve by a stab, there was complete motor paralysis of all the intrinsic muscles of the hand, which was followed by degeneration but no loss of sensation. The patient had complete control of all the flexor and extensor muscles of both wrist and fingers. In two other cases of bullet wound which passed through the brachial plexus just below the clavicle, the patient recovered complete use of all the muscles of the arm and forearm except those supplied by the musculo-spiral nerve. In neither of these cases was there any permanent anæsthesia. A temporary numbness followed the accident but sensation was soon restored.

Diffuse Injuries.—These may be produced by traction on the arm either at birth or during adult life. The mechanism of the injury is the same in each case, and consists in overstretching, to the point of rupture, of the roots entering into the brachial plexus. If the injury is sustained by the roots of the fifth and sixth cervical nerves the upper-arm type or Erb-Duchenne paralysis results. If the lower roots are affected, the "lower-arm type" or Klumpke paralysis results. Forcible traction of the arm downward will produce the former and forcible traction upward, the latter. The middle roots, *i.e.*, the seventh and eighth cervical,

invariably escape injury in all cases, except those of complete rupture of all the cords of the plexus. Paralysis of both these types has been met with as a post-anæsthetic complication, resulting from undue traction or pressure on the nerves caused by a vicious position on the operating table. Crutches applied over the shoulder during prolonged operations in the Trendelenburg position may cause the upper-arm type of paralysis, and strong traction of the arm upward above the head may cause the lower-arm type. Other rarer causes may be looked for in the following conditions: From the direct pressure of the head of a dislocated humerus or from attempts to reduce such a dislocation by traction with the heel in the axilla; from fractures of the upper end of the humerus or the neck of the scapula; as a very rare complication of fractures of the clavicle; and from the pressure of a cervical rib. A complete description of the symptoms attending the upper- and lower-arm types will be found in the article on birth palsy.

Lesions of the Whole Plexus.—These injuries are of rare occurrence. Complete avulsion causes total motor paralysis of all the muscles of the arm and forearm supplied by the plexus, followed by a rapid loss in faradic irritability and a quick appearance of the reaction of degeneration. The area of anæsthesia has been carefully studied by Sherren who has corrected the erroneous impressions of others as to the significance of the areas of normal sensation in the upper arm. Figs. 177 and 178 taken from Sherren show clearly the areas of anæsthesia and normal sensation. The boundary is marked clearly by a black line. Distal to the boundary we have a narrow zone (shown by crosses) where epicritic sensation is lost, but where protopathic sensation is still present. Distal to this zone we have an area which occupies the whole upper extremity where both protopathic and epicritic sensibility are lost. The area of normal sensation on the point of the shoulder and over the upper part of the deltoid muscle corresponds to the distribution of the acromial nerves derrived from the descending branches of the cervical plexus. That on the inner and posterior aspect of the arm corresponds to the distribution of the intercostohumeral nerve (Figs. 179 and 180). The sympathetic fibers which run in the trunk of the first dorsal nerve root are also torn, and we find the pupil on the affected side strongly contracted. It does not dilate when shaded from the light, but reacts to cocaine. In some cases we find the palpebral fissure narrowed.

The prognosis of such injuries is very unfavorable. Complete paralysis and atrophy of the muscle of the arm and forearm are inevit-

able unless the torn nerves are united. Delay in the operation is inadvisable because the distal nerve cords retract considerably and their individual elements become unrecognizable in a mass of scar tissue after the lapse of a few weeks. Bolton reported two cases operated on, one at the end of five weeks where the nerve cords were embedded in a mass

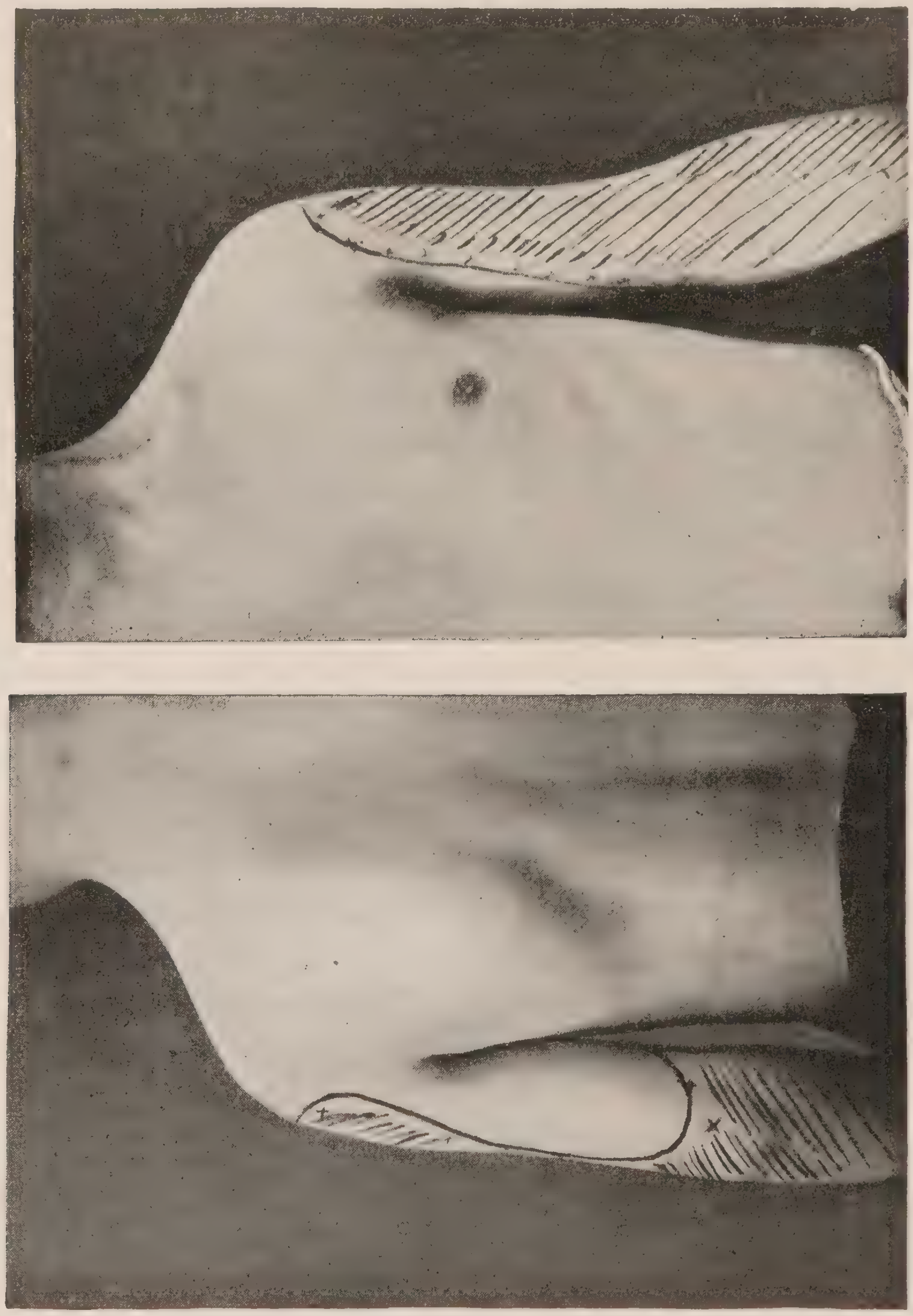

FIG. 177.—Complete division brachial plexus in supra-clavicular region. Boundaries of epicritic and protopathic sensibility. (*Sherren.*)

of recent granulation tissue, the other at the end of nine months where the separate elements were embedded in a mass of dense scar tissue. In neither of these cases was it possible to unravel the separate cords or to bring the distal and proximal ends of the severed nerves together, and the attempt at suture was abandoned. Bristow reported a case of

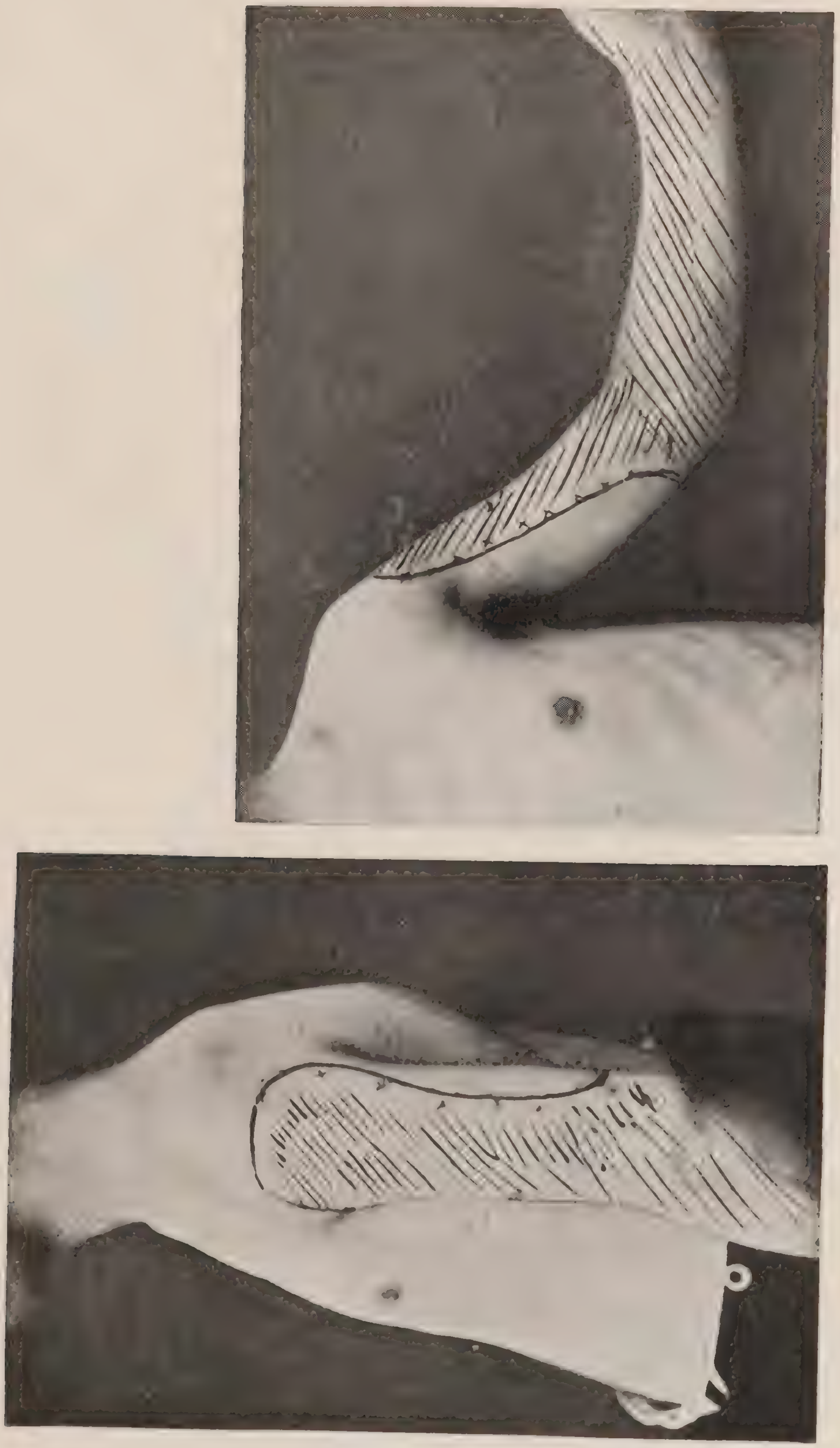

FIG. 178.—For same patient as Fig. 177. (*Sherren.*)

immediate suture of all the cords. At the end of a month the reaction of degeneration was noticed in the deltoid, biceps and triceps, and there was no electrical response whatever in the extensor and flexor groups of the wrist and fingers. He thought sensation had improved over the

FIG. 179.—Cutaneous nerves of the upper limb. Dorsal aspect. (*W. Keiller, Keen's Surg.*)

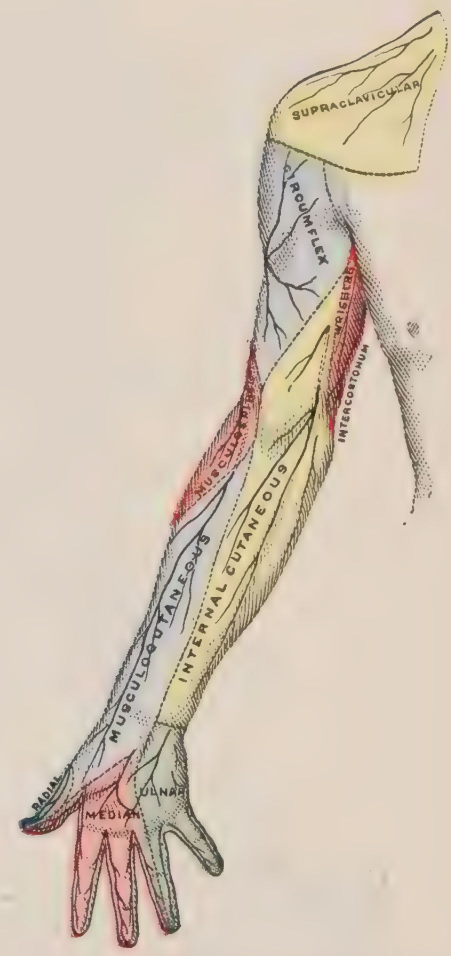

FIG. 180.—Cutaneous nerves of the upper limb. Ventral aspect. (*W. Keiller, Keen's Surg.*)

region of the internal cutaneous nerve. Later reports as to the condition of such cases as the one reported are needed before an accurate estimate can be formed as to the efficacy of immediate suture.

INJURIES OF SPECIAL ARTERIES

The Carotid Artery and Its Branches.—Wounds of the common carotid are more frequent than those of the internal carotid. Those affecting the various branches of the external carotid are fairly common but are rarely attended with serious danger to life, owing to their comparatively small size, easy accessibility and peripheral distribution. In wounds of the common and internal carotid the primary hemorrhage is often fatal before assistance is available. In cases that survive the

primary hemorrhage, the risks of recurrent and secondary hemorrhage are unusually great unless the wounded vessel is promptly tied. Even if these risks are safely passed, traumatic aneurisms make their appearance in a large proportion of cases. The accident must always be looked upon as one of the gravest in surgery, because ligature of the carotid for any reason is always a dangerous operation in middle-aged and old people owing to the collateral circulation being defective in the circle of Willis. The dangers are greatly increased in the presence of profound anæmia and sepsis. Even in comparatively young people with good arteries, death may follow rapidly on the heels of a complete obliteration of the common carotid. The writer has seen death occur from cerebral anæmia five minutes after ligature of the common carotid for a wound inflicted three days previously. The patient, a woman of 33 years of age, had suffered from a very severe hemorrhage at the time of the accident, but there had been no subsequent bleeding. Her condition at the time of operation was very fair. The right common carotid was ligatured above and below a wound that severed three-quarters of the circumference of the vessel. The patient's pulse and respiration became very rapid, unilateral right-sided convulsions made their appearance and death followed in a few minutes. In two other instances of stab wounds of the common carotid treated by the expectant method, secondary hemorrhage resulted. In each case bleeding was stopped by a ligature placed above and below the wound, but was followed by coma which proved fatal within 24 hours.

Symptoms and Diagnosis.—Usually there is only one symptom, namely, sudden profuse bleeding of the arterial type. If the case is seen at once, the diagnosis is easily made, but if some time has elapsed since the accident we may have to rely on the history. Extreme anæmia may be corroborative of the amount of blood lost, and symptoms of cerebral anæmia or absence of pulse in the peripheral arteries may suggest complete division. As previously stated, Von Wahl's sign, *i.e.*, a systolic murmur over the wounded artery, is not absolutely reliable as a symptom of partial division.

Treatment.—The general principles underlying rational treatment have been outlined before. In military practice it is neither convenient nor wise to attempt to ligature the bleeding vessel until the patient is removed to one of the base hospitals. The mortality of operations conducted on the field has been unusually high. A temporary dressing should be applied to occlude the wound and prevent external bleeding. In time, internal bleeding will cease in the majority of cases after the

formation of a large hematoma, which is often the forerunner of a traumatic aneurism. When a traumatic aneurism has formed, the case can be treated at leisure. Operations performed at such a late date are attended by a very low mortality. But, on the other hand, if the hematoma remains diffused and shows a tendency to increase in size, early operation becomes imperative; but even at this comparatively early period the loss of blood has been restored to such an extent that the prognosis is almost always more favorable than it would be if operation were undertaken immediately after the injury. In civil practice an immediate operation to secure the bleeding point is permissible if the patient's condition is satisfactory and the case is undertaken by an expert surgeon in the best of surroundings. Where these conditions do not exist, it is wiser to wait until a traumatic aneurism has formed if the progress of the case justifies such a course. If an occlusive dressing is applied and a careful watch kept on the neck, any further bleeding will form a hematoma. If this shows any tendency to increase progressively, the wound must be opened and an attempt made to secure the wounded artery at any cost. But if the hematoma, after reaching a certain size, remains stationary, an aneurism will probably form and this can be treated at leisure. During the first two weeks we can only make a shrewd guess at the probable fate of the case, and if a decision has been made to treat it on the expectant plan, we must be ready to meet emergencies quickly as they arise. Recurrent hemorrhage may appear as soon as the lowered blood pressure rises and, if repeated from time to time, may prove fatal. If an occlusive dressing has been applied, these hemorrhages may increase the size of the hematoma, the estravasated blood burrowing along the planes of the neck and producing very serious pressure symptoms. Secondary hemorrhage may appear, usually after the sixth day. This is of the gravest import. Often sudden and overwhelming, it may kill the patient in a few minutes; or it may show itself as a constant dribble which gradually saps his strength. In whatever form it appears, the treatment must be prompt and vigorous. If feasible and the patient's condition justifies it, the wound should be opened and the artery ligatured above and below the bleeding point. There is probably no operation more difficult to complete, because the wound is infected, the tissues are friable and the arteries are soft and often incapable of holding a ligature; and when, in addition, the wound is obscured by constant bleeding, ligature of the artery may be impossible. Under such circumstances the only alternative is to pack the wound with antiseptic gauze, which in rare instances may stop

the bleeding permanently, but which as a rule only gives a brief respite. Sooner or later bleeding reappears and finally kills the patient.

Subclavian Artery.—Wounds of the subclavian artery may be caused by stabs or bullet wounds. Compared with wounds of the carotid artery they are uncommon. Wounds of the first part of the artery are liable to be complicated by wounds of the subclavian vein near its confluence with the internal jugular. Also the apex of the lung is in danger. Wounds of the third part of the artery are often associated with injury to some of the cords of the brachial plexus. The prognosis of such injuries is very unfavorable. Most cases die promptly of primary hemorrhage. Secondary hemorrhage is not uncommon and is usually fatal. Hemothorax and pulmonary complications are an added danger. In cases that escape these complications, aneurisms usually develop in the course of time.

Treatment.—The remarks that have been made concerning the treatment of wounds of the carotid are relevant here also. Immediate operation is often the safest course, and, where the patient's condition admits and the artery is accessible, should be attempted. If the cases are seen after primary hemorrhage has ceased, perhaps the wisest course to pursue is to apply an occlusive dressing and place the patient under close observation, making preparations to close the wounded artery if bleeding occurs. If a circumscribed hematoma forms, a traumatic aneurism will probably result, which can be operated upon later without any great danger to the patient's life.

Vertebral Artery.—Wounds of the vertebral artery are very rare. The artery may be wounded at any point in the neck, either before it enters the foramen in the transverse process of the sixth cervical vertebra, or between the vertebræ, or as it winds round the arch of the atlas. The artery is most frequently wounded in the last situation. Owing to the inaccessibility of the artery the accident is a very serious one. In wounds of the lower portion of the neck, a severe external hemorrhage may result or a large hematoma may form in the deeper cervical planes. Wounds higher up may be complicated by injury to the spinal cord.

Treatment.—If the patient's condition justifies it, an attempt should be made to ligature the wounded vessel. Failing to reach the bleeding point, the wound should be packed firmly with gauze. Wounds of the artery above the sixth transverse process may be treated by ligature of the vertebral trunk before it enters the foramen. This procedure might stop the bleeding or check it sufficiently to enable the operator to ligature the bleeding point.

DISEASES OF THE BLOOD-VESSELS

A. Acute arteritis.

The arteries of the neck are subject to the same inflammatory processes that attack the arteries of the rest of the body. A very brief description will suffice. Matas has divided the acute processes into three main groups as follows:

1. **Pyogenic or Suppurative Arteritis.**—This occurs typically where an artery is directly in contact with virulent pus, as in acute abscesses. These are of course very common in the neck, following such affections as tonsillitis, alveolar abscesses, etc. In certain conditions of lowered resistance of the tissues and unusual virulence of the infection, the arterial wall sloughs like the cellular tissue. It is probable that gangrene of the walls of arteries would occur more frequently if it were not that they are nourished by their own vasa vasorum. The organisms usually found in these abscesses are staphylococci or streptococci or both. The results are often disastrous. While thrombosis may result and the arterial walls become occluded, as a rule the clot is defective and is easily forced out by the blood pressure behind it. Secondary hemorrhages are the rule and often prove fatal. Occasionally after an acute abscess has been opened, a smart hemorrhage occurs and this may be followed by others until the patient's vitality is exhausted.

2. **Localized Septic Endarteritis of Embolic** (*Pyæmic*) **Origin.**—This condition is the result of infected emboli which have lodged in the affected artery. The original source of the embolism may have been the valves of the heart or an infected thrombus of a more proximal artery. The immediate result of such an embolus is the blocking of the vessel and interference with the peripheral circulation, which may possibly result in gangrene. Locally, the inflammatory changes that occur around the infected embolism may result in widespread thrombosis, which may quickly break down into an abscess or later, result in the formation of an aneurism.

3. **Acute Non-pyogenic Arteritis.**—The causes of this condition are usually toxæmic and are caused by non-pyogenic bacterial infections. They are rarely caused by traumatisms. The processes are often seen following such diseases as typhoid and the exanthemata. The structural changes that occur in the arterial wall do not lead to progressive ulceration or purulent infiltration. The arteries most commonly affected are those of the lower extermity. The intima of the vessels suffers mainly. The process is one of inflammation of the coats of the intima associated with great infiltration of leucocytes ending in marked

hyperplasia and proliferation of the endothelium (endarteritis). The arteries often become so narrowed that thrombosis is inevitable.

Chronic Arteritis.—(*Syn.: Atheroma, Arteriosclerosis*).—As a preliminary to the consideration of aneurisms a short description of the essential features of this important disease is imperative. It is essential that this disease should be considered as a *malady affecting the whole arterial system*, and, that while the ravages may be more pronounced in one part of the system, *e.g.*, the large arteries (atheroma), the rest of the blood-vessels are profoundly affected by the same process. In the larger arteries, particularly in the aorta, typical inflammatory processes result eventually in the complete destruction of parts of the intima and contiguous parts of the media, in loss of the endothelial lining, in the formation of so-called atheromatous ulcers and finally in such a weakening of the vessel wall that the external coat would invariably yield to the blood pressure inside the vessels if it were not for the strengthening of the inflamed areas by the deposition of lime salts in the form of plates. Even so, aneurisms are common sequels and atheromatous changes are truly looked upon as the forerunners of nearly all the aneurisms of spontaneous origin. In the small arteries the disease usually begins in the muscular coat and results in fatty degeneration and often in calcification of the cells of this layer. The other coats are not necessarily involved in the process although they may be thickened and their elasticity destroyed. These changes can be recognized grossly in the peripheral arteries, such as the radial and temporal, the vessels becoming tortuous hard and ringed or bead-like. In other types of arteriosclerosis, the intima is primarily affected by a proliferative change which rapidly leads to obliteration of the lumen of the vessel. Further, the process often affects the veins equally with the arteries and both artery and veins and perivascular tissues are involved in a diffuse sclerogenic process. This latter condition can be demonstrated clearly during operations for ligature of markedly atheromatous arteries.

ANEURISMS

Aneurisms may be conveniently divided into two classes according to their cause, viz.: (1) spontaneous aneurisms resulting from disease of the artery such as atheromatous changes, (2) traumatic aneurisms, resulting from stabs, bullet wounds, etc.

SPONTANEOUS ANEURISMS OF SPECIAL ARTERIES

Innominate Aneurism.—Aneurisms of this vessel occur rather infrequently representing about 3 per cent. of all aneurisms. Matas divides them into four classes: (1) those arising from the artery near its origin, the aneurism often being part of a similar condition of the aortic arch; (2) those arising from the terminal portion of the vessel. In these the carotid or subclavian or both arise from the wall of the sac; (3) those occupying the entire circumference of the artery, *i.e.*, true fusiform aneurisms; (4) those where the dilatation is limited to the middle portion of the artery. The last two varieties are very rare. Almost invariably the aneurism is of a sacculated type, and the symptoms that result, apart from those of an intrinsic character such as pulsation, bruit, etc., depend on the position of the sac and the structures it presses upon. As a rule, the early symptoms are entirely intrathoracic and in some cases remain so to the end; but in most instances the sac tends to grow upward into the neck and cervical symptoms are added. In typical cases of cervical extension the pulsating tumor occupies the lower portion of the neck, behind the insertion of the sterno-mastoid muscle which is often tightly stretched over the sac. If the sac is large, it bulges in front and behind the sterno-mastoid and may reach as high as the level of the cricoid cartilage. In advanced cases and especially in those where the sac arises from the anterior wall of the vessel, erosion of the sternum and the inner end of the clavicle may occur.

Treatment.—The rational treatment of this serious affection depends on the situation of the sac in relation to the trunk of the artery. In aneurisms arising from the distal end of the artery it might be possible to apply a proximal ligature close to the origin of the artery from the aorta. The feasibility of such a procedure should first be determined by a careful study of X-ray pictures, which will give accurate information as to the situation of the sac and the probable length of artery between the sac and the aorta. Even in cases where the operation is feasible from an anatomical point of view, it is a desperate procedure and the mortality must necessarily be high. In all, six proximal ligatures of the innominate artery have been made with only one recovery (Burrell's case). It is, however, only fair to state that improved methods of obliterating the vessel such as the metal clips of Halsted or the aluminum bands of Matas may justify the operation. Hitherto, failure seems to have depended in most cases on the ligature, which too often cuts its way through the walls of the atheromatous vessel, and pro-

duces fatal hemorrhage. Distal ligature is the operation of choice in the majority of cases. The common carotid and the subclavian are simultaneously tied, beginning with the carotid, which should always be first compressed with a detachable clip to see the effect on the brain. If necessary, some of the branches of the first part of the subclavian such as the vertebral and internal mammary may be tied at the same time. The results have been surprisingly good, when one considers that the circulation of blood through the aneurism is still fairly active after the vessels have been ligated. The percentage of cures has been placed at 22 per cent. After ligature, the pulsation in the aneurismal sac does not seem to be much diminished at first, but in favorable cases it ceases in a few weeks. In one of the writer's cases the interval between ligature and final cessation of pulsation and bruit was almost a month. Cases in which the distal ligature has proved a failure can be treated by the methods used for aortic and abdominal aneurisms, viz., wiring (Moore), needling (Macewen) or the Moore-Corradi method.

CAROTID ANEURISMS

1. **Common Carotid Aneurisms.**—About 7 per cent. of all aneurisms occur in this artery. Spontaneous aneurisms are more commonly met with than traumatic, probably because wounds of the artery usually terminate fatally. About one-third occur in women, a contrast with other regions where aneurisms are about eight times as frequent in men as in women. The favorite sites for the aneurism are at its origin from the innominate (right) or from the aorta (left) or at the site of bifurcation into the internal and external carotid arteries. The right carotid is more often affected than the left.

Characteristics.—The aneurisms are rounded or oval in shape and usually develop from below upward (Fig. 181). They rarely encroach on the middle line of the neck. They form well-defined pulsating tumors, situated along the line of the vessel. The sterno-mastoid is usually spread over the surface of the sac. They have a tendency to compress and displace the trachea and larynx and the œsophagus and pharynx. They may become so closely adherent to the box of the larynx that every pulsation is transmitted to it and an upward tracheal tug becomes evident. Pressure symptoms also result from interference with the vagus, sympathetic, phrenic and the brachial plexus. Pressure on the internal jugular vein may cause dilatation of the vessels of the upper part of the neck.

Treatment.—All methods, such as rest and diet (Tuffnell), injections, needling, galvanopuncture, digital compression of the artery, etc., have been tried, but little need be said of them except that most

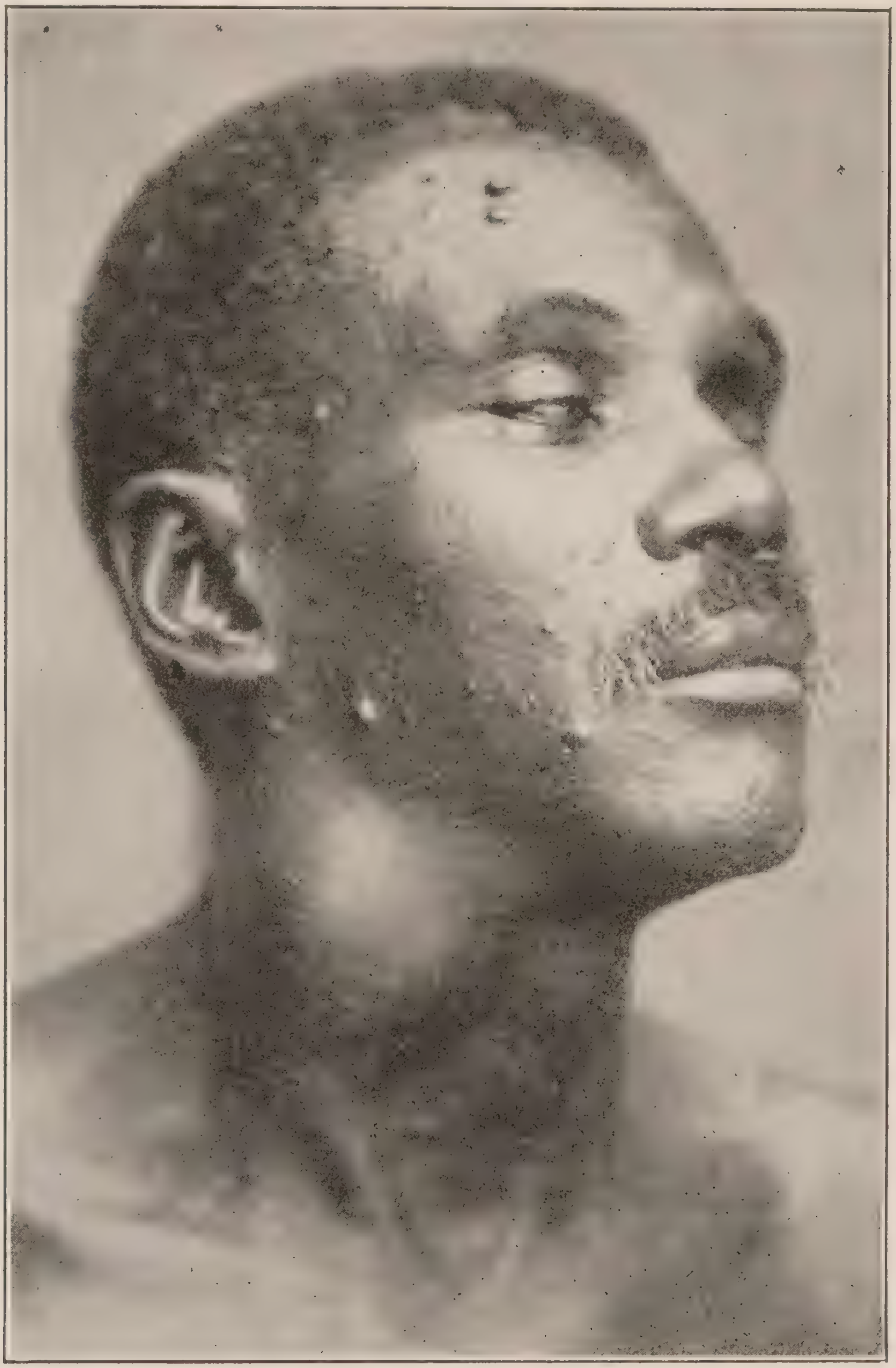

FIG. 181.—Aneurism of common carotid.

of them are dangerous. Usually operation is the method of choice and the technique must be carefully chosen if serious cerebral complications would be avoided. In every active carotid aneurism, a fair quantity of blood is still passing through the sac to the internal carotid

trunk and so to the brain. The amount is often considerable and in cases where the collateral circulation through the circle of Willis is defective, if a ligature is placed on the artery, the brain supplied by the corresponding internal carotid artery is starved and cerebral anæmia results. The effect of this is often disastrous, hemiplegia and even fatal coma making their appearance within a short period after the artery is obliterated. It is found that occlusion of the common carotid artery is so dangerous a procedure that one-quarter of all the cases show dangerous symptoms and about 10 per cent. die (Matas). After the age of 40 the dangers are always increased, because this period of life is one of a progressive arterial degeneration, which embarrasses the collateral circulation. In order to avoid the serious effects of cerebral ischæmia, it is necessary to adopt some method of obliterating the vessels temporarily and which will not injure the artery permanently at the site of compression; so that, if cerebral symptoms develop, the compression may be removed and the blood allowed to circulate along the vessel once more. It has been stated by Bernhardt that brain tissue will not die if the circulation is restored within 24 to 48 hours after it has been cut off. The time of complete restoration is probably much shorter, and complete stoppage of circulation for 12 hours would be apt to injure the ganglion cells permanently. Happily, in clinical cases cerebral symptoms usually appear in a few hours and the warning comes early enough to enable us to avoid serious consequences. Perhaps the simplest method of compressing the carotid artery lies in the aluminum strips advised by Matas; if they are used delicately it is probable that compression may be used in a reasonably healthy carotid artery for 48 hours without damage to the intima. The technique of the operation is as follows: if the aneurism is so situated that the internal carotid artery can be exposed safely on the distal side of the sac, an aluminum clip is placed on this vessel. The clip is pressed tightly enough to obstruct the lumen completely without injury to the intima. If brain symptoms occur, the clip is removed. A distal ligature such as this will often cure the case. If, however, the aneurism still pulsates, another ligature or clip can be applied on the proximal side of the sac at a subsequent operation, after which consolidation will invariably follow. In the rare cases where pulsation still continues the aneurismal sac may be opened and obliterated by suture of the open vessel mouths and sides of the sac (Matas). In aneurisms situated very high up, distal occlusion of the internal carotid is often impossible. This is to be regretted, because it is a great

safeguard against the escape from the sac of the aneurism, of soft clots which might form serious embolisms of the middle cerebral artery. Under these circumstances we must be contented with proximal occlusion. Direct attack on the aneurismal sac by one of the open methods (Antyllus, Matas, or extirpation) is admissable only in cases where failure has followed the method above outlined. Constructive endo-aneurismorraphy would be especially indicated where the collateral circulation is shown to be inadequate. But if clotting occurred in the reconstructed vessel a fatal result might follow. Partial clotting in a reconstructed artery might result in fatal embolism in the cerebral artery. Excision of the sac seems to be very dangerous and unnecessary. In cases where the wall of the sac is adherent to important structures it should be discountenanced. In other cases it is also unjustifiable because the simpler methods are very sure and much safer.

Internal Carotid Aneurisms.—Aneurisms of the internal carotid may be divided into two varieties according to their anatomical situation.

1. **Intracranial Aneurisms.**—These will be described elsewhere.

2. **Extracranial Aneurisms.**—These occur anywhere between the origin of the artery and its entrance into the carotid canal. They are very rare. They have been divided into three groups (Matas): (1) traumatic false aneurisms; (2) erosion aneurisms, caused by the ulceration of the internal carotid artery in abscess cavities (tonsillar and retropharyngeal); (3) true spontaneous aneurisms arising from atheromatous disease.

Most of the spontaneous aneurisms arise from the bulbous part of the artery near its origin. They form pulsating swellings under the upper portion of the sterno-mastoid muscle. They cause pressure on the pharyngeal wall and bulge into the pharyngeal and faucial spaces. They ought to be recognized easily by their pulsation and the absence of inflammatory symptoms. Still, very few have been diagnosed correctly, the majority being mistaken for growths and tonsillar abscesses, with serious results. Erosion aneurisms, on the other hand, which develop in abscess cavities are very difficult of recognition, because the initial history is one of inflammation, the pulsation being a later development. Pulsation is often slight, owing to the blood sac being surrounded by inflamed tissue. Fatal results have followed incisions into these aneurisms, the surgeon being under the impression that the case was one of abscess.

Treatment.—The same precautions must be used in treating these

aneurisms that have been emphasized in discussing those occupying the common carotid artery. If possible, the internal carotid artery should be compressed by a clip which can be removed if cerebral symptoms appear. If it is not feasible to obliterate the internal carotid, a clip must be put on the common carotid and this can be supplemented by ligature of all the branches of the external carotid that are accessible, to prevent blood reaching the sac by the open collateral channels. In cases of emergency where the internal carotid artery has been wounded while opening a tonsillar abscess or where an erosion aneurism has been opened, the wound should be plugged and the common carotid artery exposed and compressed provisionally while search is made for the bleeding point, which should be secured if it can be reached. Failing to reach the bleeding point, the common carotid should be ligatured permanently and in addition the trunk of the external carotid should be obliterated to cut off the collateral circulation (Wyeth). Finally, the wound should be firmly packed. Direct operations are too dangerous to be employed in this situation.

Aneurisms of the External Carotid and Its Branches.—Aneurisms of the main trunk are rarer than those of the internal carotid. It is very difficult to distinguish them from aneurisms of the termination of the common carotid or from those of the beginning of the internal carotid. Aneurisms of the separate branches of the external carotid are occasionally met with.

Treatment.—The treatment of aneurism of the trunk of the artery will depend on its position. If possible, the external carotid artery should be tied proximal to the aneurism. It should be remembered, however, that ligature too near its origin is dangerous because clots may be detached from the site of ligature and swept up the internal trunk into the middle cerebral. If the external carotid cannot be tied, a clamp should be placed temporarily on the common carotid to control hemorrhage, after which the aneurism should be opened and obliterated by the intrasaccular method. Temporary compression of the internal carotid renders this operation less bloody. Distal ligature of its branches would be worth consideration, if all of them could be exposed safely.

Aneurism of the Subclavian Artery.—Aneurisms are most frequently met arising from the third part of the artery, very rarely from the second part. They are as frequent as those of the common carotid, are more common in men and usually affect the right artery. Spontaneous aneurisms are much more common than traumatic, in which

respect they resemble those of the common carotid. As to symptoms, those arising from the first part produce symptoms exactly like those of the innominate at its bifurcation; whereas those arising from the third part resemble axillary aneurisms and have a tendency to grow downward into the axillary space. The nature of the swelling is easily recognized from the intrinsic symptoms, pulsation, bruit, etc., and from the extrinsic symptoms, pressure on nerves, veins, trachea, etc. The tendency to spontaneous cure seems to be small, the tumor usually rupturing either externally or into the trachea or pleura. In some cases a differential diagnosis between aneurism and pulsating sarcoma of the clavicle may have to be made, a task which is often difficult.

Treatment.—As Matas remarks, probably more remedies have been tried in this class of aneurism than in any other. Non-operative methods are of little use although needling by Macewen's method has accomplished a few cures. The plan of surgical attack depends on the situation of the aneurism, whether it is situated inside or outside the scalenus-anticus muscle. In the former, "intrascalenic aneurisms," proximal ligature of the subclavian is almost an impossibility. The innominate might be ligatured, but this is always a formidable operation. It is probably far wiser to use distal ligatures applied to the common carotid and the third part of the subclavian respectively. The results are usually good. In the "extrascalenic aneurisms," a proximal ligature should be applied to the artery just outside the scalenus-anticus. This will necessarily be close to the sac. If cure does not result, the aneurismal sac should be opened and intrasaccular suture used. Matas advises the immediate opening of the sac as soon as the proximal circulation is secured. He is emphatic about its superiority to extirpation which endagers surrounding structures. The mortality ought not to be heavy. In aneurisms outside the scalenus-anticus it is less than 10 per cent. (Savariand). The danger of gangrene in the arm is slight. The collateral circulation through the scapular anastomoses is usually well developed and if care is taken, during the operation, not to injure the posterior scapular artery which often arises from the third part of the subclavian, the chances of success are greater.

Arterio-venous Aneurisms.—The time honored classification of these aneurisms into two classes, viz.: (1) The aneurismal varix and (2) the varicose aneurism is perfectly satisfactory. In the former, the walls of the vein and artery are adherent and a fistulous opening passes directly from the lumen of the artery into that of the vein. In the latter, the artery and vein are separated from one another by an aneurismal

sac of adventitious formation into which the artery and vein open by separate apertures. A very important modification of this conception of a varicose aneurism is seen in cases where both artery and vein open into the aneurismal sac by a proximal and distal aperture. This condition occurs when both artery and vein have been divided by the injury and an aneurismal sac has developed between the proximal and distal

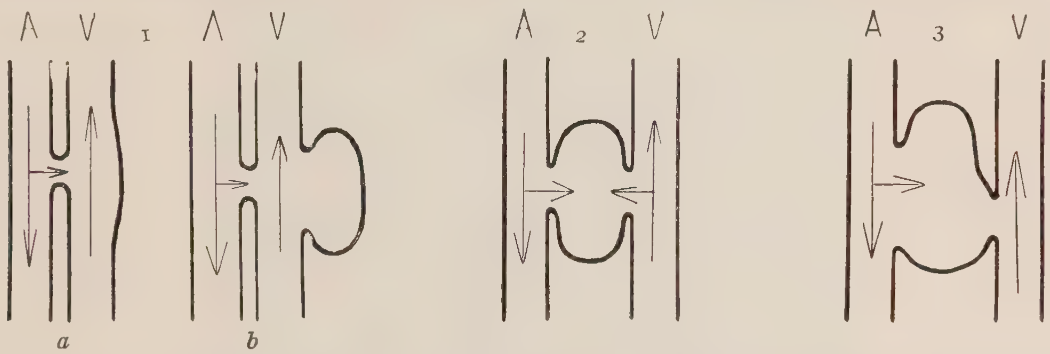

FIG. 182.—The three principal forms of arterio-venous aneurism. 1. Arterio-venous fistula (*a*); arterio-venous aneurism with venous sac, varix aneurismaticus (*b*). 2. Arterio-venous aneurism with false intermediate sac, aneurisma varicosum. 3. Arterio-venous aneurism with arterial sac, secondary arterio-venous aneurism. (*Lexer-Bevan.*)

ends of the vessels, a little blood being still propelled to the periphery along the artery, and venous blood still returning to the aneurismal sac along the peripheral venous channel. In addition, other minor, gross, pathological changes may occur, such as the formation of a saccule in the

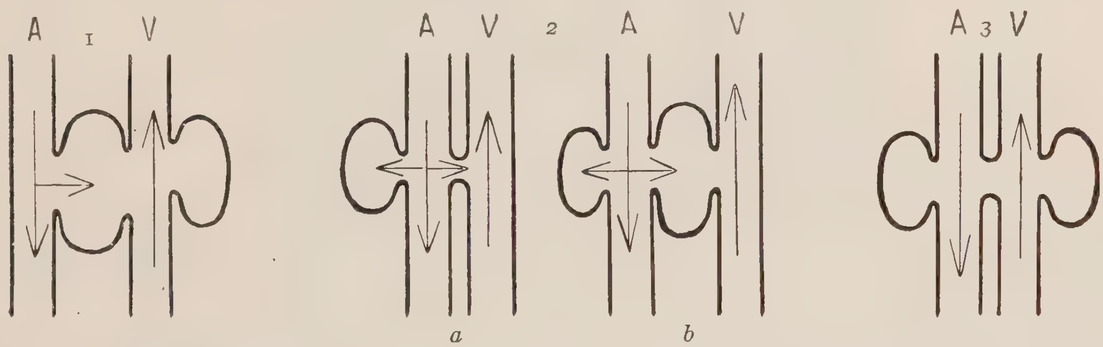

FIG. 183.—Special forms. 1. Arterio-venous aneurism with false sac and varix on outer side of vein. (Single injury of artery, double injury of the vein.) 2. Arterio-venous aneurism with direct communication in (*a*) and with a false intermediate sac in (*b*) and with a false arterial aneurism. (Single injury of vein, double injury of artery.) 3. Arterio-venous fistula, following double injuries of both vessels. The sacs lie opposite each other. (*Lexer-Bevan.*)

vein opposite the fistulous opening and even the formation of an arterial saccule (aneurism) opposite the fistula. Figs. 182 and 183 illustrate every anatomical variety.

Arterio-venous aneurisms of the arteries of the neck are rare for the same reason that traumatic aneurisms are, viz., because the majority of patients receiving wounds likely to terminate in this condition die from hemorrhage. They have been met with between the common car-

otid, the internal carotid and (rarely) the external carotid arteries respectively and the jugular vein, and rarely between the subclavian artery and vein.

Arterio-venous Aneurisms of the Common Carotid Artery and the Jugular Vein.—As mentioned above these are rare. The cause is usu-

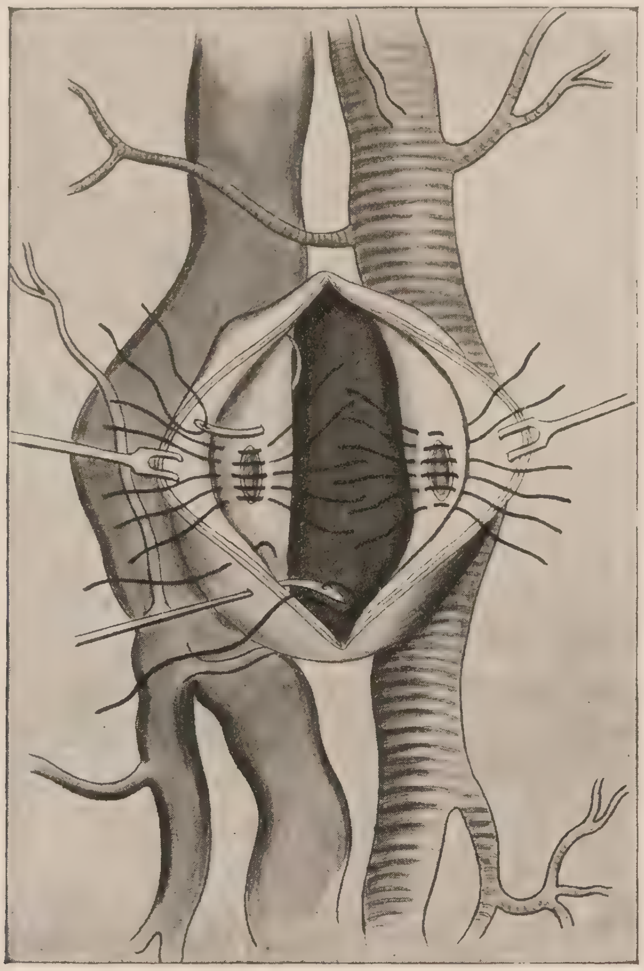

FIG. 184.—Varicose aneurism type of arterio-venous aneurism of left common femoral artery and vein, showing the application of this class of aneurisms of the Matas method of operating upon ordinary aneurisms. The opening of the femoral artery into the common aneurismal sac is shown on the right, with interrupted Lembert gut sutures in position, ready to be tied. The opening of the femoral vein is seen on the left, with similar Lembert sutures in position. On the left of the sac two gut sutures are in the act of being placed, which, when tied, will approximate the roof of the sac (including skin and intervening tissues, which are not here shown) to the floor of the sac. Similar sutures will approximate the roof and floor of the sac upon the right. (*Bickham, in Ann. of Surg., May,* 1904.)

ally a stab, gunshot or incised wound. The primary symptoms are those of hemorrhage which is controlled by pressure. The close juxtaposition of the vessels favors agglutination, but the opening between the vessels persists and arterial blood pours from the artery into the vein. In the course of time it is found that the swelling which at first consisted of extravasated blood, does not disappear but begins to show distinct signs of pulsation. If the shape of the swelling is irregularly round and of firm consistence and if on pressure it becomes smaller but

does not disappear, it is probably a varicose aneurism; but if it is oval in shape, soft and semifluctuant and can be obliterated by pressure, it is probably an aneurismal varix. In both cases marked pulsation can be seen and felt in the jugular vein. Palpation reveals a prolonged thrill. On auscultation a murmur is heard that has been compared

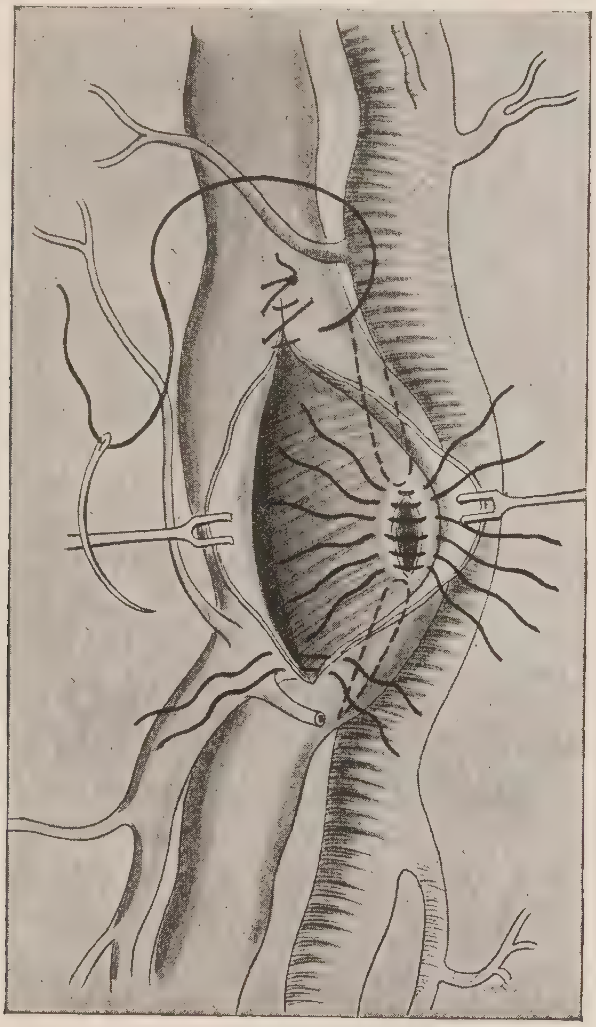

FIG. 185.—Aneurismal varix type of arterio-venous aneurism of left common femoral artery and vein, showing the application to this class of aneurisms of the Matas method of operating upon ordinary aneurisms. The opening of the femoral artery into the varicosed vein is shown, with interrupted Lembert gut sutures in position, ready to be tied. The longitudinal incision in the vein or approaching the arterio-venous opening (and which is here made somewhat unnecessarily long) is shown in the act of being closed by two methods of suturing—above, by the continuous Lembert of the outer coats; below, by interrupted ordinary sutures of the outer coats. (*Bickman, in Ann. of Surg., May*, 1914.)

variously to the hum of distant machinery, to a fly in a paper bag, etc. Owing to the obstruction to the flow of venous blood from the brain, various cerebral symptoms are noticed, such as headache, giddiness, faintness, dimness of sight, etc. The constant roaring that the patient hears makes him very irritable, restless and sleepless.

Prognosis.—The course of aneurismal varix is usually benign. There is practically no tendency for the swelling to enlarge and in time

the vein accommodates itself in a remarkable manner to the increase in blood pressure. The cerebral circulation also undergoes compensation. In varicose aneurisms the prognosis must be more guarded, although although progressive enlargement and rupture of the sac are rare terminations. Still, one must never forget that in both varieties the per-

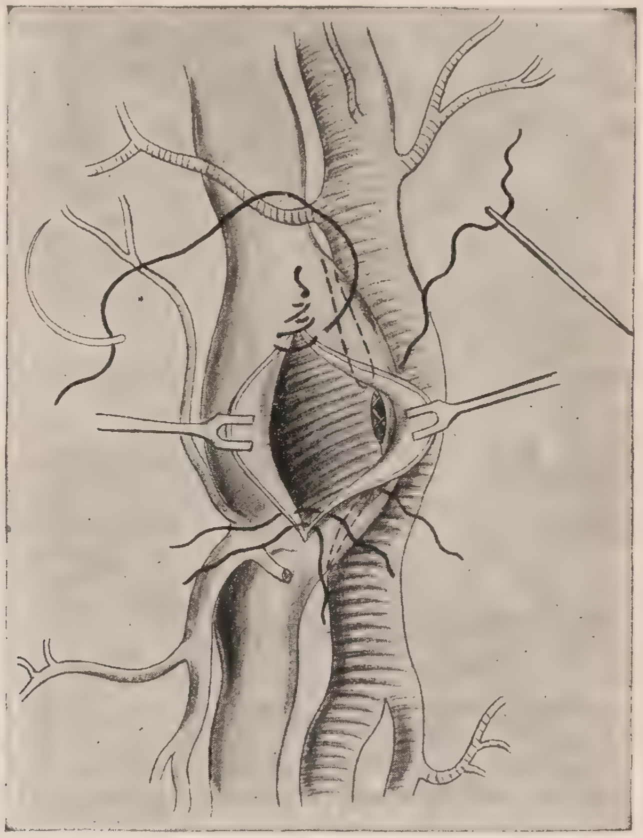

Fig. 186.—Same as Fig. 185, showing a continuous Lembert gut suture, which, having been passed through the outer coats of the thickened vein at the angle of junction of vein and artery and knotted, is passed on between the coats of the vein until its varicosed cavity is entered very near one end of, and immediately above, the first tier of interrupted sutures, and is then made to bury-in this first tier and itself in continuous Lembert fashion and, emerging at the opposite angle of junction of vein and artery, is tied in the same manner as at its entrance; this suture is not yet tightened throughout. (*Bickham, in Ann. of Surg., May*, 1904.)

ipheral circulation always suffers both from lack of arterial blood and from obstruction to venous return. There is practically no tendency to spontaneous cure in either condition.

Treatment.—Owing to the tolerance of the individual to these conditions, operative interference should not be undertaken unless there is sufficient reason. The chief indications for operative treatment are (1) progressive enlargement of the aneurism, (2) symptoms of venous stasis or dangerous obstruction of the venous circulation. It must always be remembered that both artery and vein are involved in the process and that any operation which results in obliteration of either vessel may cause serious cerebral symptoms; therefore, an operation must

be chosen which will close the anastomotic opening without closing the lumen of either artery or vein. This can be done in a very simple manner if the main circulation can be controlled temporarily. An incision is made over the aneurismal varix or over the sac of a varicose aneurism. Careful dissection of the vessels will lay bare the anastomotic opening

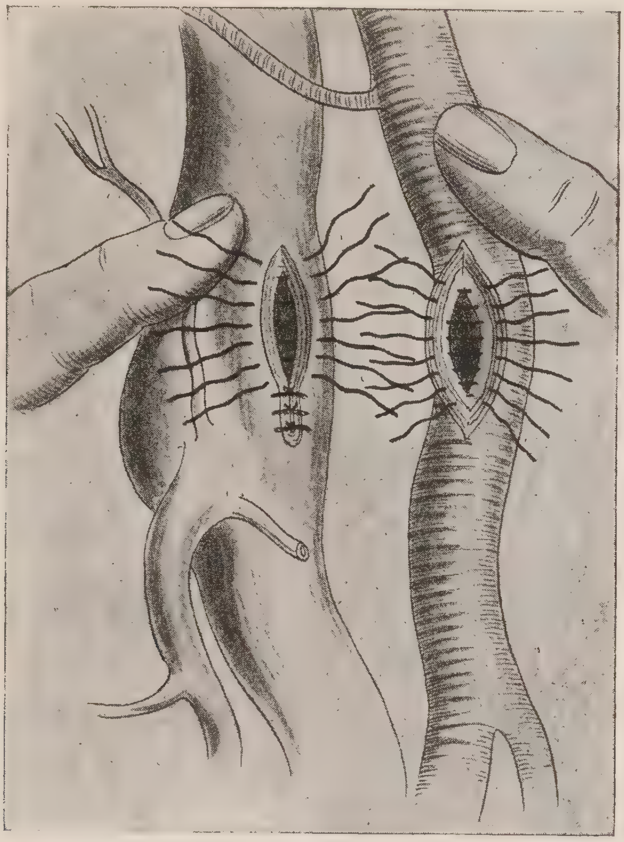

Fig. 187.—Varicose aneurism of left common femoral artery and vein, treated by excision of the sac, followed by suturing of the openings in the vessels. Upon the right, a small elliptical piece of the sac is shown connected with the arterial opening, with the first tier of interrupted Lembert gut sutures in position, ready to be tied. Upon the left, a similar elliptical piece of sac has been left connected with the venous opening. The first row of Lembert sutures has been tied, and a second tier of ordinary sutures through all the coats is being applied, burying in the first tier. Fig. 187 is the same as Fig. 184, with the sac excised. (*Bickham, in Ann. of Surg., May*, 1904.)

in the former. The artery and vein are then isolated by severing their connections and the separate openings closed carefully by sutures (Figs. 184, 185, 186 and 187). In the latter, the sac is opened and the openings into the artery and vein exposed and sutured as in the operation of aneurismorraphy. Such operations will of necessity be very infrequent in the neck, owing to the difficulty in controlling the circulation thoroughly enough to secure a dry field.

Arterio-venous aneurisms of the internal carotid are very rare. Their symptomatology and the principles underlying their treatment are identical with those of the common carotid.

Arterio-venous aneurisms of the subclavian artery and vein are also rare. Matas reports one successfully treated. The opening in the vein was sutured, but he was forced to ligate the artery above and below the opening.

DISEASES OF THE MUSCLES OF THE NECK

Atrophy.—Atrophy of the muscles of the neck may arise from any of the following causes:

1. *From Disease.*—This is usually produced by ankylosis caused by tuberculosis of the cervical vertebræ. The muscles become attenuated and wasted and much of the muscular tissue disappears. The reaction of degeneration is not present.

2. *From Inflammation.*—The sterno-mastoid muscle is most often affected. Usually the inflammation is caused by injury which ruptures some of the fibers of the sterno-mastoid causing a hematoma. Most of these cases occur in newly born children and result from injuries received during parturition. The inflammatory process set up by the rupture of muscle results in the absorption of the extravasated blood and in the replacement of muscular fibers by scar tissue. The resulting contraction is often the cause of wry-neck.

3. After division of the nerves supplying muscles, which frequently occurs during operation and through accidents, atrophy invariably occurs. After division of the hypoglossal, hemiatrophy of the tongue always follows. The sterno-mastoid and trapezius undergo partial atrophy only, after division of the spinal accessory, because they receive a separate nervous supply from the cervical plexus. If both sources of nerve supply are divided, total atrophy is inevitable. When the muscles are cut off from the trophic centers, the reaction of degeneration soon appears and the muscle undergoes complete degeneration, the fibers disappearing eventually, their place being taken by fibrous tissue infiltrated with fat.

4. *Poliomyelitis* in some rare cases affects the anterior horns of the upper cervical region of the cord. The result is paralysis and atrophy of some of the muscles of the neck.

Myositis.—*Simple myositis* occurs in the neck usually as the result of traumatism. Hematogenous myositis (Mikulicz) is a common result of injuries of the sterno-mastoid received during parturition and is a common cause of congenital torticollis.

Infective Myositis.—Usually two forms of this disease are described: (1) direct, infective myositis; (2) metastatic, infective myo-

sitis. (1) Direct infection may occur from disease of neighboring structures such as a lymphatic gland or the vertebræ. Extension to the muscles is much less frequent in acute infection (staphylococcic and streptococcic) than in the chronic (tuberculous). In acute abscesses of the neck the muscle may be bathed in virulent pus without having its vitality impaired in the least degree. In tuberculosis of the lymphatic glands we often find the sterno-mastoid extensively infiltrated with the disease.

Metastatic infections are very rare in the muscles of the neck. Apart from the typical pyæmic processes they are met with in individuals where resistance is at a low ebb from want, exposure or excesses. They are more frequently met with in the muscles of the thigh and result in the formation of abscesses which often contain a thin sanious or grumous pus. The cavities are often large and ragged. The constitutional symptoms are often severe, and in many cases convalescence is slow and tedious or a fatal issue may result. A curious form of metastatic inflammation of muscles has been described, which is characterized by the presence of pain in a number of muscles and the appearance of indurated areas with œdema over them. The affected muscles are often contracted. Incision into these areas fails to show any pus. Recovery is the rule. To this disease the name acute polymyositis has been given.

Myositis Ossificans Progressiva.—This disease, the cause of which is unknown, usually begins in the muscles of the neck and back. They become suddenly swollen and painful, and as the swelling subsides induration is observed, which becomes bony in consistency. One attack follows another, different groups of muscles being involved until nearly every group of muscles in the body may be affected. The disease is always progressive, and if the patient lives long enough all the muscles of the body may become ossified.

Tuberculosis of Muscles.—The muscles may be affected with tuberculosis in one of two ways: (1) by direct extension of the disease from a neighboring structure such as a lymphatic gland or the vertebræ, or (2) the tuberculous infection may be metastatic, the primary infection being usually in a distant gland (bronchial) or organ. The former condition is by far the more common. In advanced cases of tuberculosis of the cervical lymph nodes, the sterno-mastoid especially and any of the deeper muscles, such as the splenius capitis, digastric and mylohyoid, are often infiltrated to such an extent that removal of large parts of them is imperative during the radical operation on the lymph

nodes. In metastatic infections, which are quite rare, the disease may show itself as one or more solitary nodules, or it may assume the miliary form. The nodules pass through every stage of induration, caseation and abscess formation. Sometimes a whole muscular belly may be involved. The treatment should be wide excision of the affected area and in some cases excision of the whole muscle.

Syphilitic Affections of Muscle.—In the early stages of syphilis, muscular affections are rare and are usually shown by the presence of vague distressing pains of a rheumatic character, and in rare instances by the appearance of contractures. We have no knowledge of the pathology of these early symptoms, but they are probably produced by circulatory disturbances. The contractures affect the biceps and other long muscles of the body and persist for a long period if the case is untreated. Under specific treatment, the symptoms disappear rapidly. In the tertiary stages of syphilis muscular affections are very common and appear usually under one of these forms. (1) The syphilitic inflammation affects the muscles in a diffuse form (diffuse syphilitic myositis). The muscles affected show a diffuse hardening and swelling, occupying the greater part of their extent and attended with pain and loss of function. If untreated, the muscular tissue undergoes atrophy and sclerosis follows. In the neck the sterno-mastoid is usually affected. (2) Gummatous infiltration of muscle is probably the most common manifestation of the later stages of syphilis. It is said to be a common manifestation in hereditary syphilis and occurs most frequently in the sterno-mastoid. The changes noticed are those seen in gummata generally, viz., induration, usually of a slow, painless character, followed by softening and ulceration. If untreated, the resulting necrosis may be extensive, and serious deformities may result. Even if treated successfully before ulceration occurs, much muscular tissue is sure to be destroyed and will be replaced by scar tissue, the result being a non-contractile rigid cord instead of a living muscle. Acquired torticollis may result from a gumma of the sterno-mastoid.

Parasitic Disease.—With the exception of actinomycosis (see p. 339), parasitic diseases are very rare. Hydatid cysts, which are of rare occurrence in muscles, have been found in the muscles of the neck. *Trichiniasis* occurs in these muscles as part of the general systemic infection in this disease.

Injuries to Muscles.—*Open Wounds.*—These may be incised or of the gunshot variety. Apart from possible injury to vital structures they are of little consequence. They are liable to infection which must

be guarded against by the usual precautions. If the muscular fibers are extensively severed, the ends will retract and sutures may be required to prevent serious deformity. In this connection mention should be made of the importance of careful suture of the platysma after transverse incised wounds of the neck, to prevent deformity.

Subcutaneous Injuries.—Partial or complete rupture of the muscular fibers may result from injuries. The accident may be produced by a direct injury such as a blow or crush or kneading, or it may be brought about by vigorous muscular contraction against resistance. In the neck the sterno-mastoid muscle is the one usually affected. In new-born children, and especially after difficult labors, the sterno-mastoid muscle is often seriously bruised and ruptured. A hematoma results. As time passes it becomes absorbed and in the majority of cases no evil results, but in some instances permanent cicatricial changes follow and the sterno-mastoid becomes permanently contracted, producing one of the varieties of wry-neck. In adults, rupture of the sterno-mastoid is a rare injury. It is usually partial. If many of the transverse fibers are divided, a deep groove is both visible and palpable. Much blood is poured out and for a time the true diagnosis may be obscure. Later on, as the blood is absorbed, a transverse depression appears in the neck. The treatment will depend on the extent of the rupture. If extensive, the muscular fibers should be reunited with sutures. Open operation, however, is only necessary for cosmetic purposes, as the movements of the neck are not necessarily impaired even after complete rupture or division of the sterno-mastoid.

Tumors of Muscles.—*Primary tumors* of muscles are rare. A fair number of cases of angioma have been described as occurring in the sterno-mastoid muscle. Perhaps the most common primary tumor occurring in the muscles of the neck is *sarcoma.* The sterno-mastoid muscle is the usual seat of the disease. The tumor may be of the round- or spindle-celled variety and may show evidence of myxomatous degeneration and contain cystic cavities. It may occupy a considerable extent of the muscle. In the early stages, it is entirely confined to the muscular sheath and shows no tendency to extend beyond it. Later, it will infiltrate the neighboring tissues. *The treatment* should be extensive removal. The only wise course to pursue is to remove the muscle in a cleanly manner from end to end.

Secondary Tumors of Muscle.—All cancers of muscle are secondary. In the neck, they invariably result from direct extension of the growth from the primary focus (mouth, œsophagus, larynx) or from metastatic

deposits. True metastatic deposit in the muscles from cancer at a distance is very rare, although the muscles are occasionally infected by extension of metastatic growths in the bones (vertebræ, clavicle, skull).

TUMORS OF THE NECK

Endothelioma.—Certain glandular tumors of the neck have been described as belonging to the group of endotheliomata and having their origin in the endothelium lining of the lymph channels. Clinically they present symptoms of a nodular, glandular enlargement definitely circumscribed and usually painless. The rate of growth varies. Usually it is comparatively slow. The growth arises, as a rule, in the upper substerno-mastoid group of the lymphatic glands. When removed in the early stages it appears to be definitely encapsulated, and there is often a long period of months or years of freedom from recurrence. If it recurs, the second growth is usually at a lower level than the first, arising apparently in the supraomohyoid gland, and if it is allowed to reach a large size projects downward toward the clavicle. It grows much more rapidly than the first. Removal of this growth sometimes gives freedom for another longer or shorter period. If a second recurrence follows, it usually makes its appearance in the pretracheal glands and the lower cervical glands of the other side of the neck, or it may attack the supraclavicular glands of the same side.

Histologically there is usually a change of type, the growth becoming more cellular after each recurrence. These growths have already been referred to in the article on Hodgkin's disease, as anomalous malignant growths having certain features resembling lymphosarcomata and others resembling Hodgkin's disease.

Lipoma.—Fatty tumors of the neck are very common. They are divided into three varieties: (1) the subcutaneous, (2) the subfascial, and (3) the diffuse.

The subcutaneous form is of frequent occurrence. The usual situation is the nape of the neck, where they often become very large. They are definitely lobulated and are separated easily from the deeper structures.

The subfascial form is rather rare. It is often congenital and occurs in young children. The prolongations of the tumor burrow under the deep cervical fascia and surround the vessels and nerves but do not contract adhesions to them. Consequently, the tumor can usually be shelled out easily without danger. Pressure symptoms have occasionally been noticed.

Diffuse lipoma (Fig. 188), is also a rare disease and seems to be confined to middle-aged men who have otherwise no tendency to obesity (Madelung). The disease may occur in any part of the neck. Often rolls of fat extend round the neck like a collar, or there may be a mass

FIG. 188.—Diffuse symmetrical lipomas. (*Lexer-Bevan.*)

of fat in each lateral region separated by a median groove. The accumulation is usually in the subcutaneous tissue, but it may spread to the subfascial space and surround the deep vessels and nerves. Unlike the other forms of lipoma, there is an absence of a definite boundary between the tumor and the tissues.

The diagnosis of fatty tumors is usually very easy. The subfascial forms are often mistaken for other conditions and, when deeply situated, accurate diagnosis may be impossible.

Treatment.—The subcutaneous and subfascial types can usually be removed with ease and safety. In operating on the diffuse variety, great care must be taken. Total removal requires an extensive, deep and intricate dissection and may prove a formidable task. Operation in successive stages, or attempts to reduce the size of the tumor by injections of ether, can hardly be recommended.

CYSTS OF THE NECK

1. **Dermoid Cysts.**—*Sequestration dermoids* derived from infolding of the epiblastic layer are found usually in the middle line of the neck just above the sternal notch. As a rule, they lie between the sternal heads of the sterno-mastoid muscle and in front of the trachea. They are rarely large, but occasionally they may dip behind the sternum into the upper part of the anterior mediastinum. They very seldom cause any symptoms. Removal is seldom advisable. Tubulo-dermoids may be derived from either (*a*) the branchial clefts or (*b*) the thyroglossal duct. The former are situated on the lateral aspect of the neck, the latter are in the middle line. They are described elsewhere.

2. **Cystic Hygroma of the Neck.**—Tumors that have been described from time to time under this name or that of "hydrocele" of the neck have not always been of one kind. Many have been dermoid cysts and others lymphangiomas. There seems little need for confusion between hygromata and dermoids, but the line of distinction between them and lymphangiomata is not always clear. Dowd, who has lately written on this subject, believes that the term hygroma should be confined to "cystic tumors which have endothelial linings and serous contents and which grow with much power through the tissues of the neck or downward under the clavicle into the axilla or pectoral region." The clinical histories of the cases vary. In some instances the growth is noticed at birth. In others, the neck is normal at birth and the swelling does not make its appearance until after the lapse of months or even years. The disease is, however, essentially one of the early months or years of childhood. In most cases the swelling increases rapidly in size, after its first appearance. It usually starts in the posterior triangle just above the clavicle and spreads forward under the sterno-mastoid muscle across the deep vessels of the neck which it covers, or it may spread downward under the clavicle toward the axilla, or extrapleurally into the anterior

mediastinum. The tumor varies in size from that of a small orange to that of a cocoanut. It is usually soft and fluctuant. The contents are clear, thin and serous. They do not coagulate spontaneously. The rate of growth is very slow and regular. The general health is not affected. The final destiny of the cysts does not seem to be understood clearly. It would appear from the study of some of the cases as if the

FIG. 189.—Cyst lining stained with protargol, showing delicate outline of endothelial cells. (*Dowd, Annals of Surg.*)

tendency was to increase in size and to burrow indefinitely. Many cases, however, reach a certain size and then cease growing and remain stationary for many years. The writer had the privilege of seeing in 1896 a grown woman, with a stationary hygroma of the neck, who had been a patient of Sir James Paget when a child. The tumor had not increased in size for 30 years. A paper by Dowd (Annals of Surgery, July, 1913) contains perhaps the best account of the morbid anatomy and etiology of this condition. He reported four cases, all occurring in young children aged respectively $2\frac{3}{4}$ years, 20 months, 11 months

and 2 years. In each case the cyst occupied some part of the posterior triangle with extensions, respectively, into the anterior mediastinum (case I), under the clavicle into the axilla enveloping the pectoralis minor (case II), up the neck burrowing under the trapezius muscle

FIG. 190.—Congenital (?) hydrocele of neck.

(case III), and over the deep vessels and nerves of the neck (case IV). The cavities of the cysts varied in shape. Among them were irregular, unilocular cysts with recesses, two-compartment cysts with an hourglass constriction, and typical multilocular cysts. The sac walls varied

in thickness, in some places being as much as an inch thick, in others as thin as 2 mm. The walls consisted of fibrous tissue with a slight degree of round-celled infiltration. The inner lining of the wall was found in two cases to be covered by large pavement epithelium (see Fig. 189), the outlines of which were demonstrated with a stain of protargol. The contents consisted of a thin serous fluid of a yellowish color. In one case pus was found which contained pneumococci and

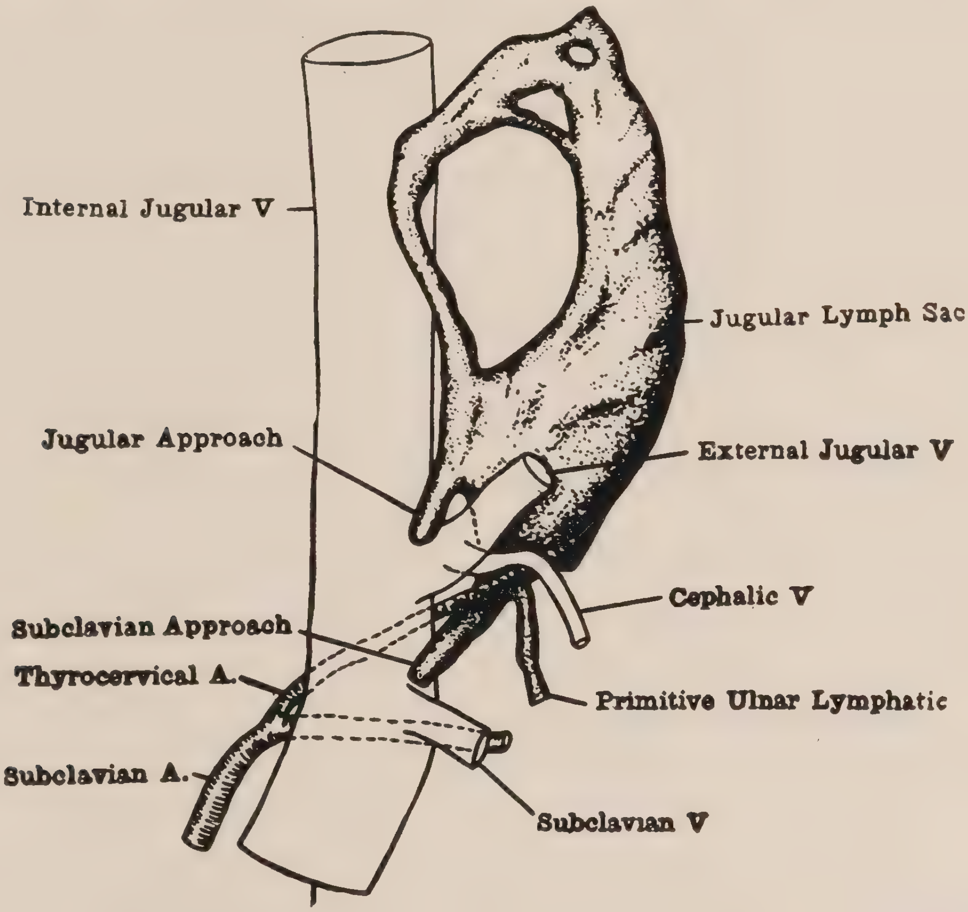

FIG. 191.—A reconstruction of the left jugular lymph sac of an 11 mm. cat embryo. (*McClure and Sylvester. Dowd, Annals of Surg.*)

streptococci, a condition evidently due to accidental infection. The case figured by the writer occurred in a young girl aged 15. After growing four months it reached the size shown in the picture (see Fig. 190), no trace of swelling being present previously. It occupied the whole of the lower part of the right supraclavicular triangle, extending downward about an inch below the clavicle, and forward almost to the middle line. An X-ray picture of the cyst, after injection with bismuth mixture, showed that it did not extend downward into the thorax and axilla. The contents were serous and yellow in color. At the operation it was found to extend both in front and behind the sterno-mastoid and to have intimate connections with the deep vessels of the neck. It was also closely connected with the scalenus-anticus muscle and the cords of the brachial plexus. It was dissected free from all the structures with

unusual ease. The cyst was roughly unilocular with irregular recesses. The walls were for the most part very thick, being in places fully ¼ in. The lining was smooth and shining. The walls consisted of fibrous tissue infiltrated with round cells. No pavement endothelium could be demonstrated on the lining membrane.

The origin of these cysts has never been settled. The suggestion made by Dowd that they arise from lymphatic tissue seems to be strongly supported by the study of the lymphatics in the neck region in mammals (Fig. 191). The lymphatics develop as secondary structures which are not primarily connected with the veins, but open into them later. If this connection fails, we may have a segregation of lymphatic tissue which may produce the cysts under discussion. Another strong argument in favor of this view lies in the fact that the neck contains more lymphatic tissue than any other region of the body, the axilla standing second, and that hygromata are most common in the neck, the axilla being the next most common site for their occurrence.

Hemangioma (*Vascular Nævus*).—Vascular tumors occur in the neck quite frequently.

Hemangioma Simplex.—This form may be confined to the substance of the true skin, when it is invariably formed by capillaries or small venules, and is known as the *cutaneous variety*. It is identical with the port-wine stains so frequently met with on the face. It may be present in the subcutaneous tissue at the same time. It usually consists of collections of small venules which are full of blood, which can be seen shining through the skin covering them. Often the skin is affected and nodules or excrescences or folds like blackberries are formed. The cutaneous is often associated with and anatomically part of the next or cavernous variety.

Hemangioma Cavernosum.—The structure of this variety is identical with that of the corpus cavernosum penis. The blood is contained in venous spaces which connect with one another. Often only one or two arteries carry the blood to the tumor, but numerous veins may be present to carry it away. The tumors may occur in any part of the neck, and may be situated either in the subcutaneous tissue or under the deep fascia. As a rule they have no definite outline. When subcutaneous, they show themselves as soft compressible tumors resembling lipomata. Often their exact nature is betrayed by the presence of dilated veins in the skin covering them. In a large number of cases their true nature is unknown until revealed by operation. This is especially true of those situated under the deep fascia. Those deeply

situated often have very close relationships with the deep vessels and nerves. The diagnosis is often impossible. Every soft compressible tumor in the neck should be looked upon with suspicion.

Treatment.—The difficulties and dangers of excision cannot be overestimated. Even in the subcutaneous varieties operation may be tedious, bloody and dangerous. In the subfascial forms it can be hardly recommended safely. The cases should be left alone unless the tumor is increasing rapidly. Electrolysis will destroy many of them and hold others in check. It is difficult to employ it in the deep-seated tumors.

Lymphangioma (*Lymphatic Nævus*).—*The capillary forms* of lymphangioma are rarely met with in the neck. They are more common in the submucous tissue of the cheek and tongue.

Lymphangioma cavernosum has been met with very rarely. It invariably occurs in the supraclavicular fossa as a soft compressible fluctuating tumor, rarely larger than an orange. It consists of numerous cysts, some of which communicate with one another. The contents are thin and milky. It has intimate connections with the jugular and subclavian veins. It is probable that cavernous lymphangiomata arise from the embryonic lymphatic sacs which precede the formation of the permanent lymphatics of the lower portion of the neck. Reference has been made to this in the article on hygroma.

CAROTID GLAND

(*Syn. Glandula Intercarotica*)

The normal gland is an inconstant structure, varying in size from 4 to 7 cm., which is found near the bifurcation of the common carotid artery usually more closely attached to the internal carotid near its origin. It is roughly oval in shape and possesses a well-formed sheath which penetrates the interior, dividing it into lobules (Figs. 192 and 193). It is well supplied with blood derived from several small arteries which arise from the common or external carotid trunks. The lobules into which the gland is divided are full of epithelial cells of many shapes. Many are round or oval; others are spindle-shaped. In some localities they are collected into rounded masses by fibrous septa and resemble cell nests or even glomeruli (Zellballen). The blood-vessels penetrate each lobule and the capillaries are in intimate relationship with the separate cells. The function of the gland is not definitely known. Luschka looks upon it as a nervous structure. Most authors now consider it a vascular organ, although some of its features suggest an analogy to the coccygeal gland and adrenal body. The embryology

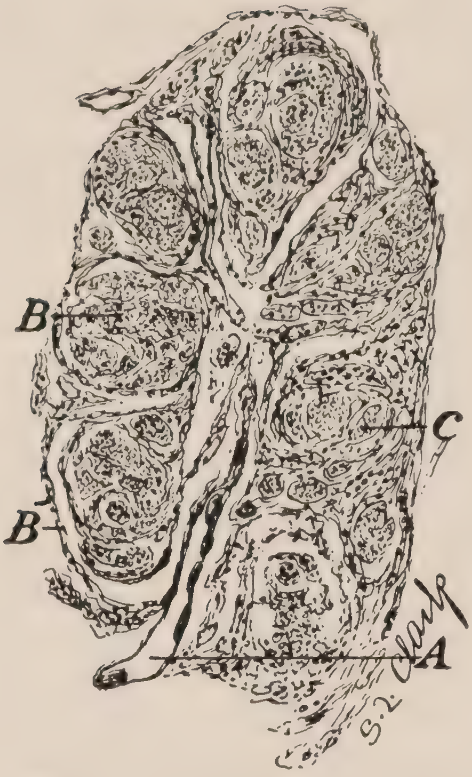

FIG. 192.—Normal carotid gland (Funke). *A*, Main artery; *B*, lobule; *C*, Zellballen of German writers. (*Keen and Funke, Journ. A. M. A.*)

of the gland is still under discussion. Its epithelial origin from the endoderm of the third branchial cleft has been advanced. Probably the view of Paltauf and Katschenko that it arises from the adventitia of the internal carotid is more nearly correct. Under ordinary circumstances the carotid body, when present, grows until puberty, when it undergoes atrophy. Very rarely it may continue to grow and a tumor will result. The rate of growth is unusually slow and regular, and years may elapse before it becomes as large as a walnut. The tumor never becomes very large. Half of the cases seen so far have been over 30 years of age, but most of them had been present many years. Men and women seem equally liable to the disease.

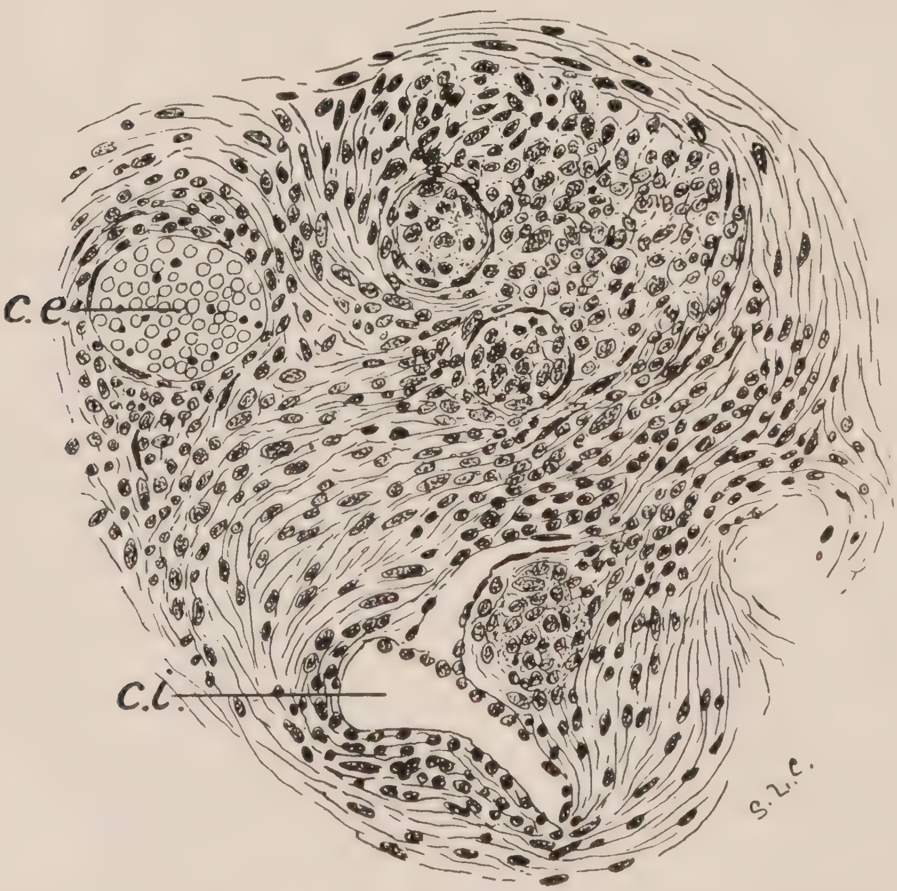

FIG. 193.—Carotid gland from a 4.5 cm. human embryo (Paitauf). *ci*, Internal carotid; *c.e.*, external carotid. (*Keen and Funke, Journ., A. M. A.*)

Symptoms.—The tumor is placed at the bifurcation of the carotid. It is round like a hen egg, and often of the same size. It is freely movable from side to side but fixed from above downward. Pulsation is evident, but it is clearly transmitted and never expansile. There is rarely much pain in the tumor or symptoms of pressure on or involvement of the nerves of the neck. In a few cases narrowing of the pupil and vasomotor paralysis have been noticed.

The diagnosis is very difficult. Most of the cases have been found while operating for the removal of glandular or fatty tumors of the neck. The operations have been extremely difficult and very bloody. It is practically impossible to remove the growth from the carotids without splitting it up lengthwise, and this procedure is to be condemned because it has been followed by frequent recurrences. The growth can be removed in a satisfactory way only by ligaturing the three carotids and removing the fork of the carotids and the growth in one piece. The appearance of the growth in the fork of the carotids is very characteristic, the tumor lying in it like a meal sack thrown over the shoulder (Fig. 194). Dissections of the specimens removed show that it is impossible to dissect the tumor from the blood-vessels without running serious risks of leaving some tissue behind (see Fig. 195).

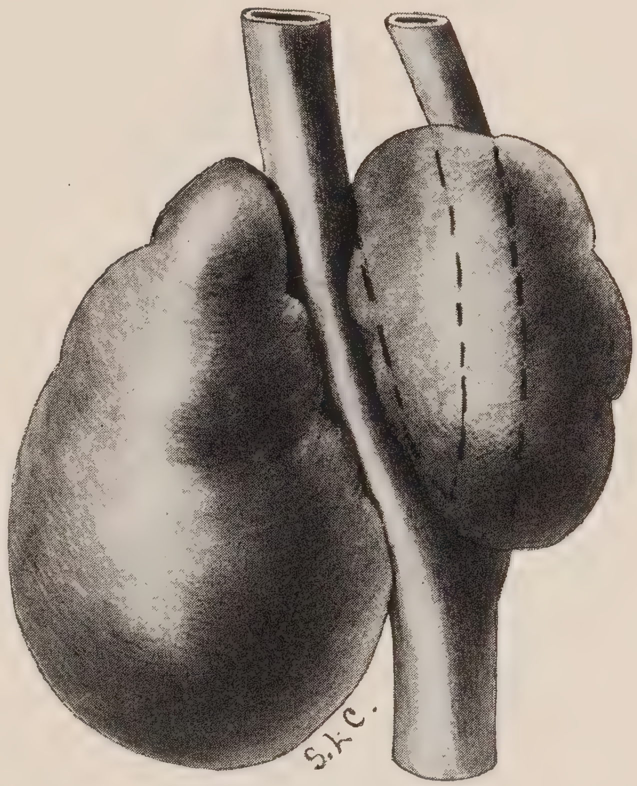

FIG. 194.—Relation of the tumor to the carotids like a meal sack thrown over the shoulder. (*Keen and Funke, Journ. A. M. A.*)

The mortality has been very high. Keen collected 26 cases operated on with seven speedy deaths, a mortality of 27 per cent. In addition to these deaths, four others were expected to die in a short time after the report. Further, among the recoveries only seven appeared to be without complications, the rest suffering, some from hemiplegia and asphasia, others from aphonia or hoarseness. Douglas has collected five more cases with one death and four recoveries, bringing up the number of cases to 31 operated cases with eight deaths, a mortality of 25 per cent.

The reason of the high mortality is not difficult to see. In 20 of the cases all three carotids were tied, a procedure that of itself is attended by a high mortality. It can be confidently reckoned that ligature of the common carotid for any condition will be followed by a mortality of at least 25 per cent.

The macroscopic appearances of these tumors show them as nodular bodies of firm consistence and of a reddish-brown color. There is often a well-marked capsule which passes inward, dividing the tumor into irregular compartments. On section the color is gray interspersed with dark red areas. Microscopically, the growth conforms to the type of endothelioma. The main structure under the capsule is usually typically alveolar, the walls of the spaces consisting of fibrous trabeculæ and delicate capillaries. The cells in the alveoli vary in size, and are irregular in outline and usually possess large nuclei.

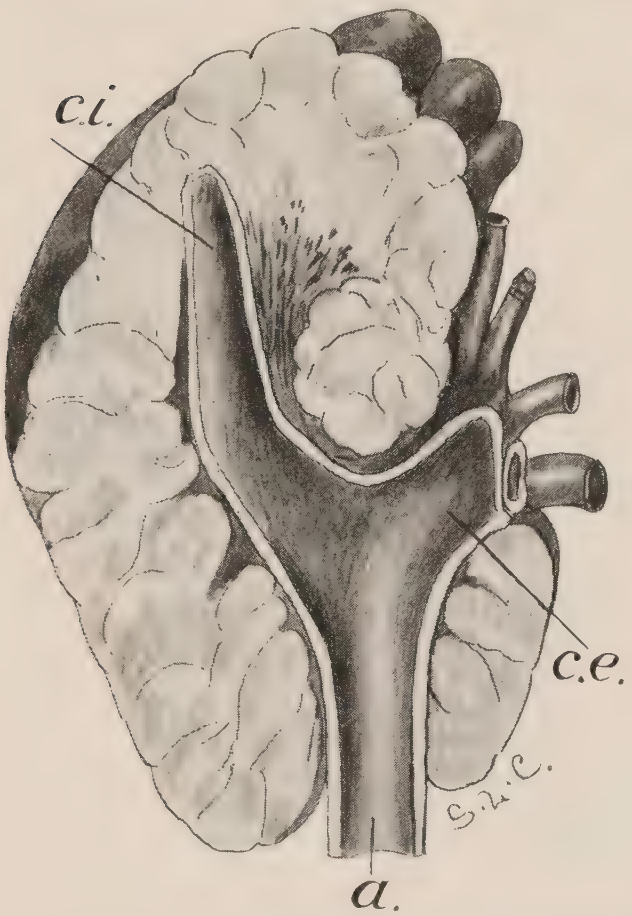

FIG. 195.—*a*, Common carotid; *c.i.*, internal carotid; *c.e.*, external carotid. (*Keen and Funke, Journ. A. M. A.*)

Treatment.—Considering that tumors of the carotid body grow very slowly and as a rule do not cause any serious symptoms of pressure, and that the operation for their removal may require ligature of the common carotid with resection of parts of the internal and external trunks, a procedure followed by a high mortality in itself, operation on such tumors should be discountenanced unless serious functional trouble results from pressure on important structures or rapid growth of a malignant nature commences.

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SECTION XVIII

LARYNX, TRACHEA AND BRONCHI

BY

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PITTSBURG, PENNA.

DIRECT LARYNGOSCOPY AND BRONCHOSCOPY

Direct laryngoscopy and bronchoscopy are procedures using straight and rigid tubes which serve as specula by drawing out of the way tissues which normally obstruct the view, or by dragging the tissues to be examined into a new position in the line of direct vision. Their development has revolutionized the surgery of the larynx, trachea and bronchi. They are used through the mouth, though in the early stage of development bronchoscopes were sometimes passed through a tracheotomic wound. Greater skill and improved instruments have rendered the tracheotomic route obsolete. Both these procedures are in themselves practically free from any vital danger. In cases of respiratory obstruction danger may arise from lack of promptness in performing bronchoscopy. Tracheotomy is always justifiable for dyspnœa, but it is not justifiable for the purpose of passing the bronchoscope; and, indeed, in cases in which tracheotomy had already been done, it has been found much more satisfactory to insert the bronchoscope through the mouth.

Instruments.—The instruments for direct work upon the larynx, trachea and bronchi may be divided into two classes: those using light reflected down from above, and those using a small light at the distal end of the tube. Good work is done with both forms of illumination, and, doubtless, efficiency depends more upon the skill and experience of the individual operator. Kahler's laryngoscope and bronchoscope (Fig. 196) and Brünings (Fig. 197) are the most used of the reflected-light instruments. Killian, who is the originator of bronchoscopy, uses the headlamp of Kirstein who was the originator of direct laryngoscopy. Ingals, Mosher and the author prefer distal illumination (Fig. 198). Besides the tubes, there are needed various forceps, sponge carriers, hooks and other accessory instruments.

Direct Laryngoscopy.—This procedure, called "direct" laryngoscopy in contradistinction to indirect, or mirror laryngoscopy, has

entirely superseded the indirect method for all except diagnostic purposes.

Anæsthesia.—For children no anæsthetic, general or local, is required for direct laryngoscopy for either diagnosis or operation upon the larynx. For adults, local anæsthesia obtained by painting the interior of the larynx with a 20 per cent. solution of cocaine will give

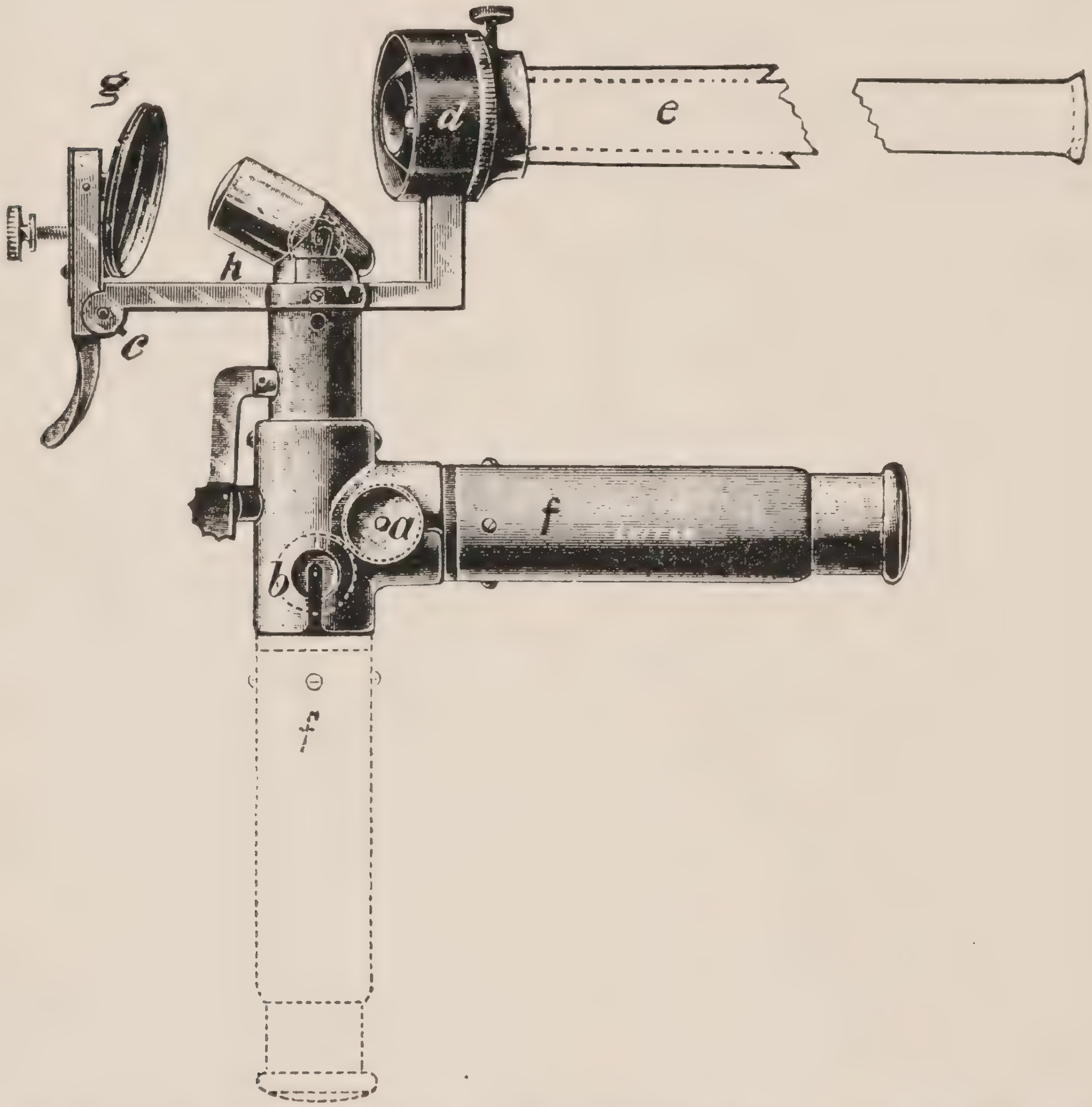


FIG. 196.—Kahler panelectroscope. The tubes used with this are similar to the sliding tubes of Brünings. The rays of light from the lamp, *h*, are reflected by the mirror, *g*, into the tube, *e*. The endoscopist's eye is placed at the notch in the mirror, *g*. The mirror can be thrown out of the way for the introduction of instruments by pressure of the thumb on the arm, *c*.

absolute analgesia. The hypodermic injection of 1/4 gr. of morphine, about half an hour before operation, will diminish the reflexes. Atropin may be added to diminish secretions.

Asepsis.—The field cannot be rendered aseptic, but in view of the fact that we encounter pneumonia, diphtheria, syphilis, tuberculosis and various pyogenic infections, and as, moreover, a patient may be

more or less immune to the organisms which he himself harbors, yet exceedingly susceptible to any nominally identical organisms introduced from without, it is absolutely essential that every detail of aseptic operating-room technique be carried out in every procedure. Oral antisepsis including thorough cleansing of the teeth and gargling and rinsing the mouth with 20 per cent. alcohol will practically eliminate septic risks.

Position of the Patient.—Direct laryngoscopy and bronchoscopy in children are always done in the recumbent position. The same may be said of bronchoscopy in adults. Direct laryngoscopy in adults,

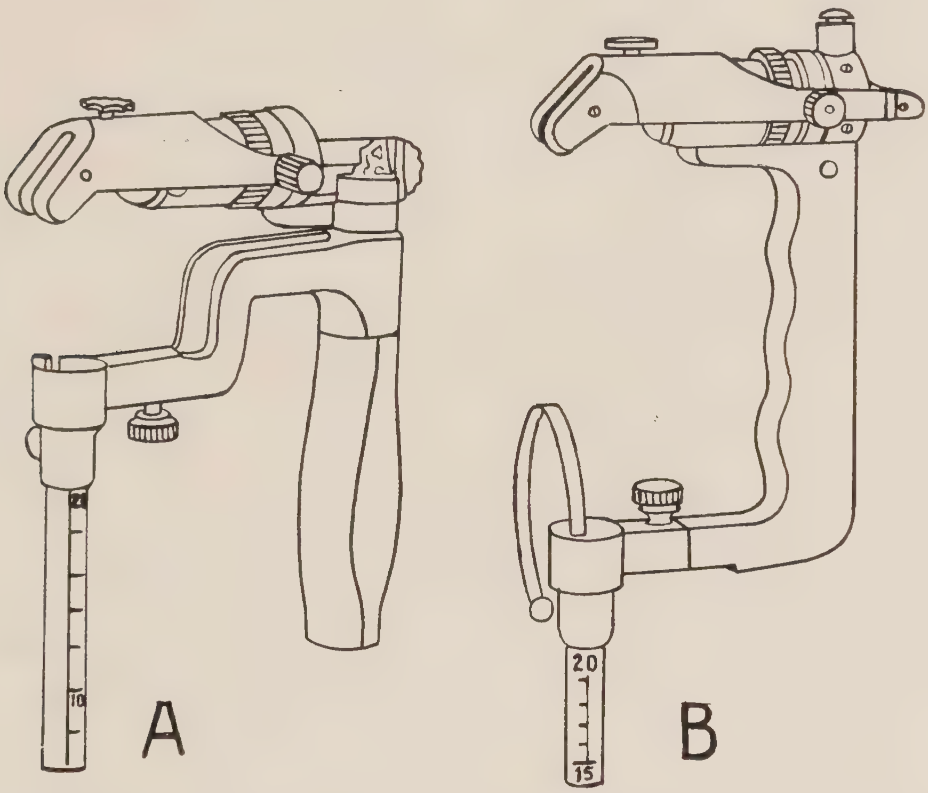


FIG. 197.—Brünings' two illuminating handles for laryngoscopes, bronchoscopes and œsophagoscopes.

under local anæsthesia, is usually done in the sitting position except in foreign-body cases. The absolute essential to all direct work is to have the head and neck in a strongly anterior displacement. This means that the head must be very far forward in the sitting position, and as high as the table or higher in the recumbent position. The head should be extended on the occipito-atloid joint. Flexion of the head forward can be advantageously used in direct laryngoscopy as demonstrated by Mosher and Johnston. Flexion, however, is not suited to bronchoscopy. When extension is referred to, it means strictly extension of the occipito-atloid joint and not extension of the cervical vertebræ, which should be on an inclined plane forward. This forward position must

be maintained by the assistant who holds the head, and at the same time prevents it from rotating.

Technique.—Exposure of the glottis with a straight endoscopic tube requires the displacement forward of the tongue and all of the tissues attached to the hyoid bone. After skill is acquired, the amount of pressure necessary to produce displacement can be very much dimin-

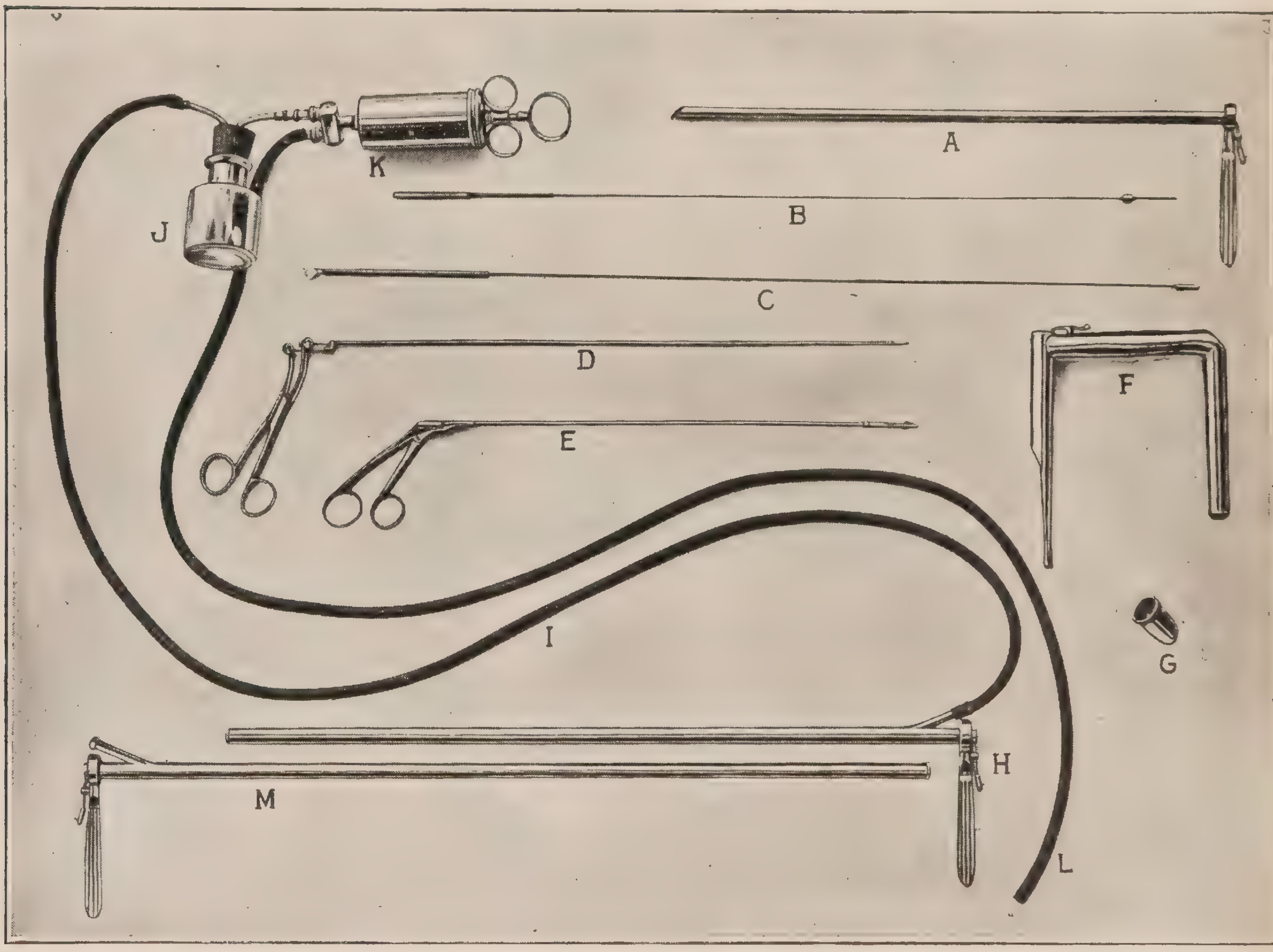


FIG. 198.—Chevalier Jackson's instruments for direct laryngoscopy, bronchoscopy and œsophagoscopy: *A*, bronchoscope; *B*, olive bougie for œsophagoscopic bouginage; *C*, sponge-carrier for sponging the field and obtaining specimens of secretion from the bronchi; *D*, forceps for removing foreign bodies; *E*, forceps for removing tissue; *F*, direct laryngoscope, called also slide-speculum and laryngeal speculum; *G*, bite-block; *H*, œsophagoscope with tubing (*I*) leading to aspirator *J*,*K* for removal of secretions without interrupting work. The tubing, *L*, is connected with positive-pressure side of the syringe, *K*, for use when needed to blow out obstructions, such as clots of pus, food, etc., that have been aspirated into the drainage canal of the œsophagoscope. At *M* is shown a gastroscope. In almost all cases the œsophagoscope in found to be long enough for gastroscopy.

ished by using a narrow tube at the side of the tongue, but in this position the landmarks are very much less easily recognized and the less skilful will be bewildered unless they pass the instrument over the dorsum of the tongue. Glottic exposure by the latter route is divided into two stages.

First Stage.—The operator holds the laryngoscope in his left hand

(Fig. 200) while with his right index finger he raises the patient's upper lip so that it cannot be pinched between the laryngoscope and the teeth. The distal end of the laryngoscope is passed backward over the median line of the dorsum of the tongue, and, depressing the tongue, in the direction of the dart at *A*, Fig. 201, the upper edge of the epiglottis will

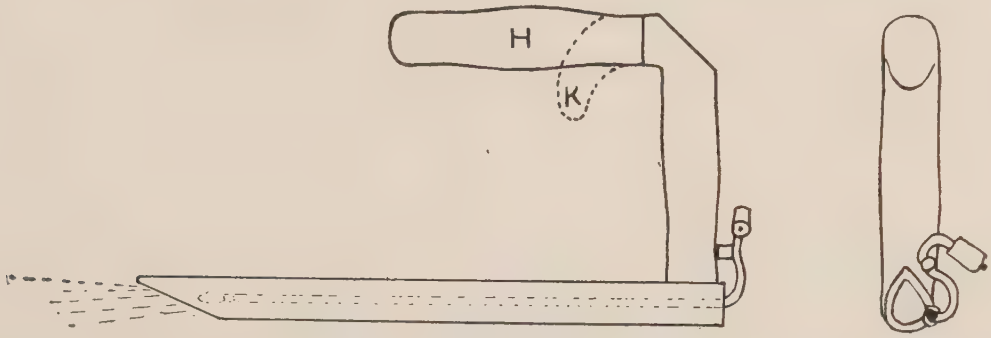


FIG. 199. Laryngoscope with heart-shaped lumen devised by the author especially for direct laryngeal operating, rendering easy the exposure of the anterior laryngeal commissure in every case. It is not adapted to the passage of bronchoscopes.

come into view. The identification of the epiglottis must never be slighted, and great care must be taken not to go beyond it without identifying it.

Second Stage.—Having identified the epiglottis the next step is to pass the spatular end of the speculum posteriorly to the epiglottis

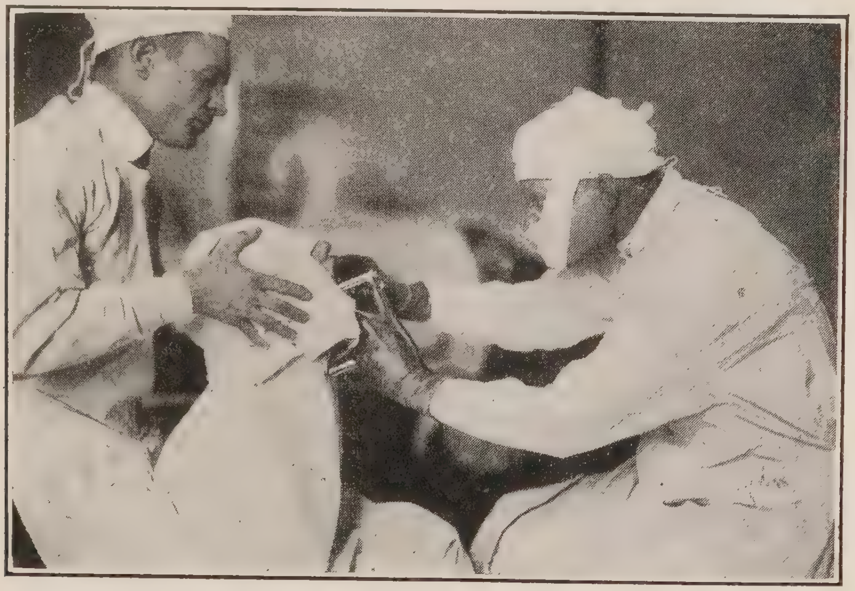


FIG. 200.—Direct laryngoscopy. First stage. (*Jackson.*)

for a distance of about 1 cm. or 1.5 cm. (slightly less than 1 cm. in a child). These measurements are only approximate; experience must be relied upon for proper gauging of the depth.

Third Stage.—Without permitting the laryngoscope to go deeper, the larynx is exposed by a forward movement of the spatular end of

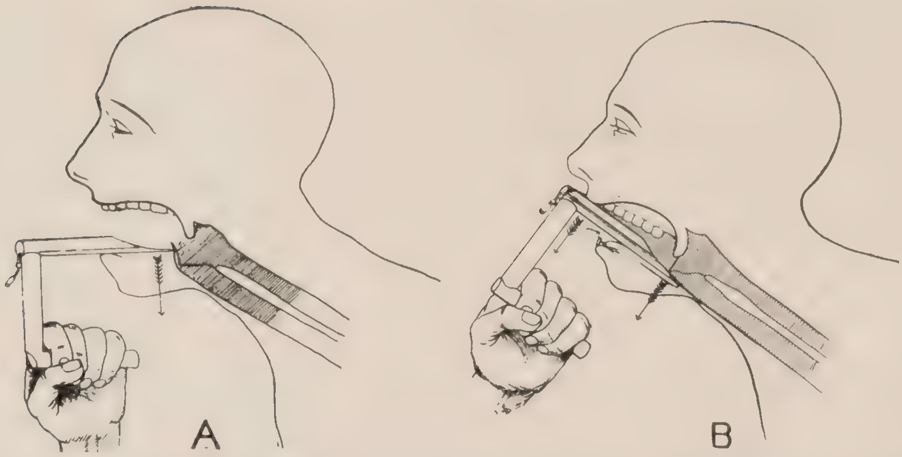


FIG. 201.—Schema showing the first and third stages in exposing the larynx in direct laryngoscopy. At the left the tongue is being depressed as indicated by the dart, causing the epiglottis to project into the line of vision as shown in the lower illustration. The laryngoscope is inserted deeper constituting the second stage. At the right is shown the third stage, the drawing forward of the epiglottis and all of the tissues attached to the hyoid bone with the *tip* of spatular end, thus exposing the spasmodically closed larynx. At the next inspiration the larynx will open, exposing the cords and glottis. (*Jackson.*)

FIG. 202.—Showing the author's position of the operator, patient and assistant for direct laryngoscopy on adult patients under local anæsthesia. The sitting position of the operator renders laryngeal exposure easy for patient and operator; whereas the usual standing position of the operator throws the patient into a posture that renders laryngeal exposure difficult as well as throwing the trachea out of line. The illustration shows the third stage, with full exposure of the larynx. (*Jackson.*)

the laryngoscope in the direction of the dart at *B*, Fig. 201. On the proper execution of this movement depends the knack of success. It is, perhaps, best described as an effort to pull the epiglottis and hyoid bone downward, outward and forward toward the operator with the tip of the spatular end. The patient's whole head should be pulled forward by the power exerted. Great care must be taken not to fall into the error of using the upper teeth as a fulcrum for the prying forward of the anterior pharyngeal tissues. Such a use of leverage will defeat its own object. When first seen, the glottic spasm is very likely to have closed the larynx and a deep inspiration must be waited for,

FIG. 203.—Introducing forceps into bronchoscope for seizing foreign body in the bronchus. (*Jackson.*)

the patient being encouraged and pacified if alarmed; he should be told to take a deep breath, and to continue deep breathing.

The laryngoscopic picture differs very much from that obtained with the mirror because of the difference in the point of view and also because the larynx is shown at its true depth, whereas with the mirror there is a foreshortening illusion.

Under general anæsthesia the amount of pressure needed for displacement of the tissues obstructing the view is very slight because of the relaxation. Under local anæsthesia the necessary pressure can be very much diminished by using a small tube and working at the side of the tongue. In doing this it is very necessary to remember the dis-

tortion produced by the angle of approach, and also to prevent the error of mistaking the aryepiglottic fold for the epiglottis itself. This lateral route presents great advantages in operating on growths located at one side of the larynx, as shown in Fig. 217, the tube being inserted from the side opposite to that on which the growth is located. Except for exposure of the opposite side, the tube is nearly vertical, and not at the angle shown. The best instrument for direct endolaryngeal operating by the laterolingual route is that shown in Fig. 199. It may be used on either side of the tongue, but, usually, the right side is preferred for the recumbent patient, the left side for the sitting patient.

Direct Laryngoscopy for the Introduction of Insufflation Anæsthesia Tubes.—The patient is necessarily in the recumbent position and

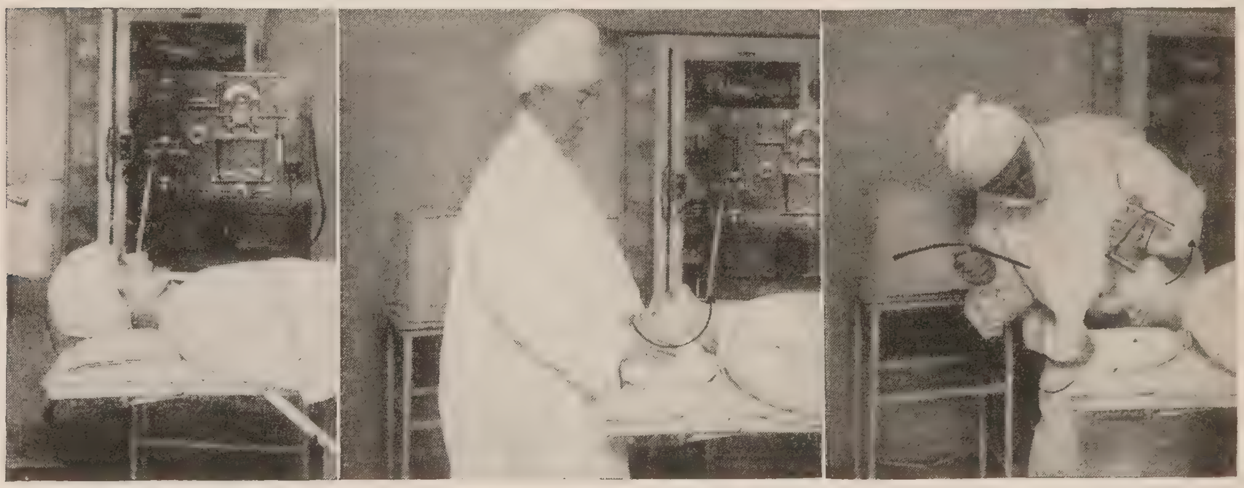


FIG. 204. FIG. 205. FIG. 206.

FIG. 204.—Photograph of patient with head upon a pillow, the head flexed. In this position it is easy to examine the larynx with the laryngoscope for diagnosis, but the larynx will not be exposed in a line with the tracheal axis so that this position is not adapted to the passing of tubes through the laryngoscope.

FIG. 205.—The pillow is removed, the head is flat on the table and the anæsthetist is beginning to force the head into the extended position. The thumbs are on the forehead and the fingers are at the side of the head. The direction of motion is shown by the dart. (*Jackson.*)

FIG. 206.—The anæsthetist is lifting with the tip of the laryngoscope in the direction of the dart. The laryngoscope is always held in the left hand. The right hand, of which the index has been protecting the upper lip, has now received the catheter from the nurse.

should be fully relaxed by the preliminary administration of the anæsthetic by inhalation in the ordinary way. With practice the larynx of any patient can be exposed without any anæsthetic, general or local, but for the introduction of insufflation tubes the patient is to be anæsthetized anyway and the procedure is greatly facilitated by full

relaxation of general anæsthesia. The patient's head should rest upon the table. The anæsthetist should cover the head with a towel and produce forcible extension by placing his two thumbs on the forehead with his fingers under the occiput as shown in Fig. 205. The motion is to press the forehead downward toward the patient's feet and thus to throw the chin and larynx high. The head should be maintained in this position while the anæsthetist introduces the laryngoscope and, by a strong lifting motion with the *tip* of the spatular end of the speculum, tries to lift the patient's neck off the table with the spatula tip as soon as the tip is placed below the epiglottis, which in all cases should be first identified.

Introduction of the Bronchoscope.—The introduction of the bronchoscope is easy to those who have mastered glottic exposure with the direct laryngoscope, and no one should attempt bronchoscopy until he can promptly expose the larynx with the laryngoscope held in the left hand. The bronchoscope is inserted (Fig. 207) with the right hand. Each in-

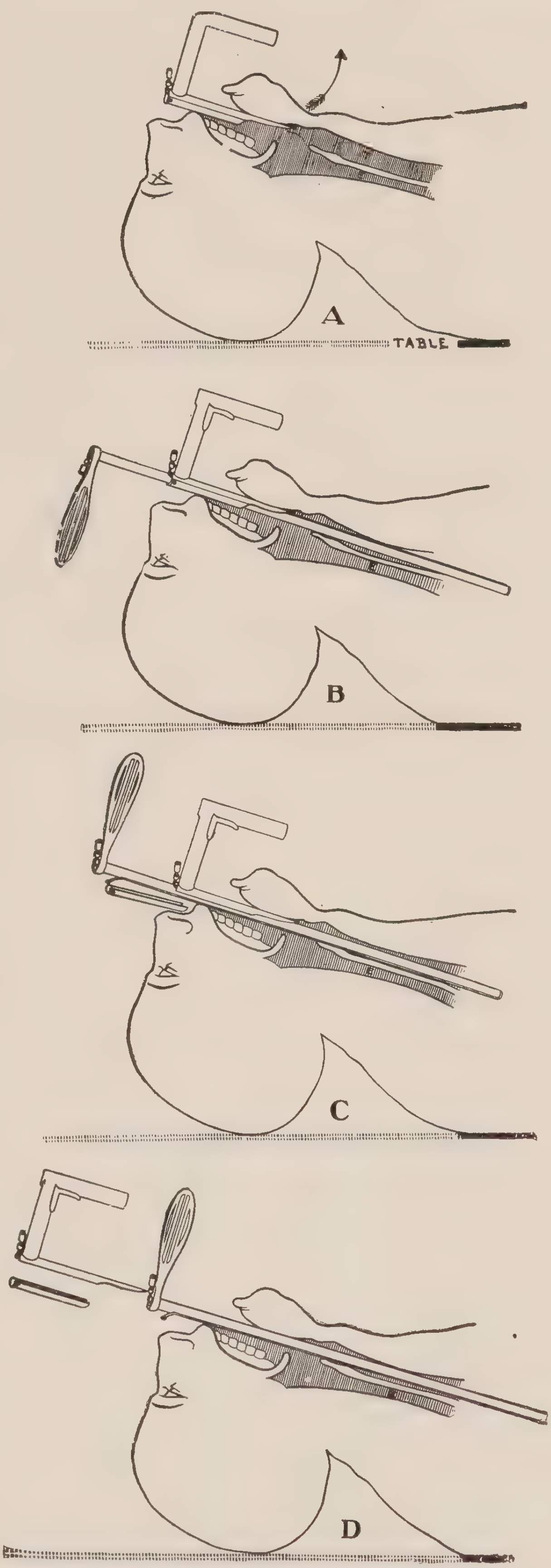


FIG. 207.—Schema illustrating oral bronchoscopy. The portion of the table here shown under the head is, in actual work, dropped all the way down perpendicularly. It appears in these drawings as a dotted line to emphasize the fact (that the head must be above the level of the table during introduction of the bronchoscope into the trachea. *A*, exposure of larynx. *B*, bronchoscope introduced. *C*, slide removed. *D*, laryngoscope removed leaving bronchoscope alone in position. (*Jackson.*)

strument is lighted by its own lamp there being two separate cords and circuits from the battery. The glottis being exposed with the left hand, the bronchoscope is taken in the right hand, the handle being horizontally out to the right. This brings the lip of the bronchoscope to the right of the glottic chink as shown in the circle. Waiting for an inspiratory abducting excursion of the vocal cord, the bronchoscopic lip is moved slightly to the left and slipped through the chink. The laryngoscope, which is necessarily constructed heavily for displacement, is now removed, leaving the light and delicate bronchoscopic tube for the work within the trachea and bronchi.

In passing down the trachea the bronchoscope ordinarily will find its way into the right bronchus, the orifice of the left bronchus being missed unless watched for. When it is desired to enter the left bronchus, the patient's head should be moved to the right and the handle of the bronchoscope rotated so as to stand out horizontally to the left by which means the lip of the bonchoscope will have a tendency to enter the left bronchus and the carina at the bifurcation is thus readily identified. This identification must be always assured before going deeper. On the left side the upper lobe bronchus is the only very large branch given off, all below that being the inferior lobe bronchus. On the right side the upper lobe bronchus is also a large branch. Just below it and passing off anteriorly will be found the middle lobe bronchus, all below that being the inferior lobe bronchus which gives off dorsal and ventral branches.

FOREIGN BODIES IN THE LARYNX

The symptoms produced by lodgment of a foreign body in the larynx depend largely upon its size. Small foreign bodies usually cause coughing which quickly subsides, and thereafter there may be no symptoms for a number of days until the inflammatory reaction produces all the symptoms of laryngitis. In children all of the symptoms of diphtheria may be present and a number of such cases have come to the author where antitoxin has been given, the child having aspirated the foreign body unknown to the parents. All cases of horaseness in children should be examined by the direct laryngoscope. In adults a sensation of pricking and desire to cough may be constantly present. Very large foreign bodies produce cyanosis and all the alarming symptoms associated with a fight for air.

Removal of Foreign Bodies from the Larynx.—A patient supposed to have a foreign body in the larynx should not be allowed to raise

his head lest the intruder be aspirated into the deeper air passages. A large proportion of the foreign bodies in the bronchi were at an earlier stage known to be in the larynx. Indirect laryngoscopy may be used if desired for the examination of adults, but this must be done in the recumbent position. In children indirect laryngoscopy is impossible and the direct method only is available. In either adults or children the head should be lowered on an inclined table so that if the intruder is dislodged it cannot be aspirated and gravity will work in favor of removal rather than in favor of aspiration. The long alligator forceps of Mosher should be used through the laryngoscope.

Direct laryngoscopy renders removal so quick and so certain that tracheotomy is no longer thought justifiable for the removal of a foreign body if direct laryngoscopic instruments are available. If the foreign body is threatening asphyxia, the cardinal rule of doing a tracheotomy early rather than later should be followed.

FOREIGN BODIES IN THE TRACHEA AND BRONCHI

The first *symptom* of a foreign body having entered the trachea is cough, usually violent. Sometimes there is also a blood-streaked expectoration. In almost all cases after the first few days all symptoms subside and the patient feels that he must have been mistaken in regard to the entrance of the foreign body. Later, however, inevitably, a cough, at first slight, will set in and the patient will gradually lose health and strength until ultimately at the end of a year or more the patient will die of all the symptoms of tuberculosis or of lung abscess. Round smooth foreign bodies are sometimes coughed out, but heavy bodies rarely are, and pointed bodies such as pins and tacks never are. Pins, needles and similar bodies have a ratchet-like action, the point preventing return while nothing resists the advance until the foreign body has reached the smallest bronchus it can enter.

The physical signs associated with foreign body are very misleading and are never of value taken negatively. If one bronchus is completely obstructed there will naturally be the physical signs of loss of air on the corresponding side, but if air can pass the intruder the symptoms are apt to be bilateral because the physical signs in such a case are produced by secretions which get into the uninvaded as well as the invaded side. Intermittent dyspnea may be due to a valve-like action of a flat foreign body. All cases with a foreign body history should be sent to the röntgenologist even if the foreign body be one not opaque to the ray, because the intruder of which we get a history may not be the same

as the one actually present, as, for instance, when a pin from the cook's clothing, getting into the food, is mistaken for a bone. If the radiograph show a foreign body, bronchoscopic removal is facilitated, but if the radiograph be negative, a bronchoscopy should be done anyway.

Localization is greatly aided by the author's positive films of the tracheobronchial tree (Fig. 208).

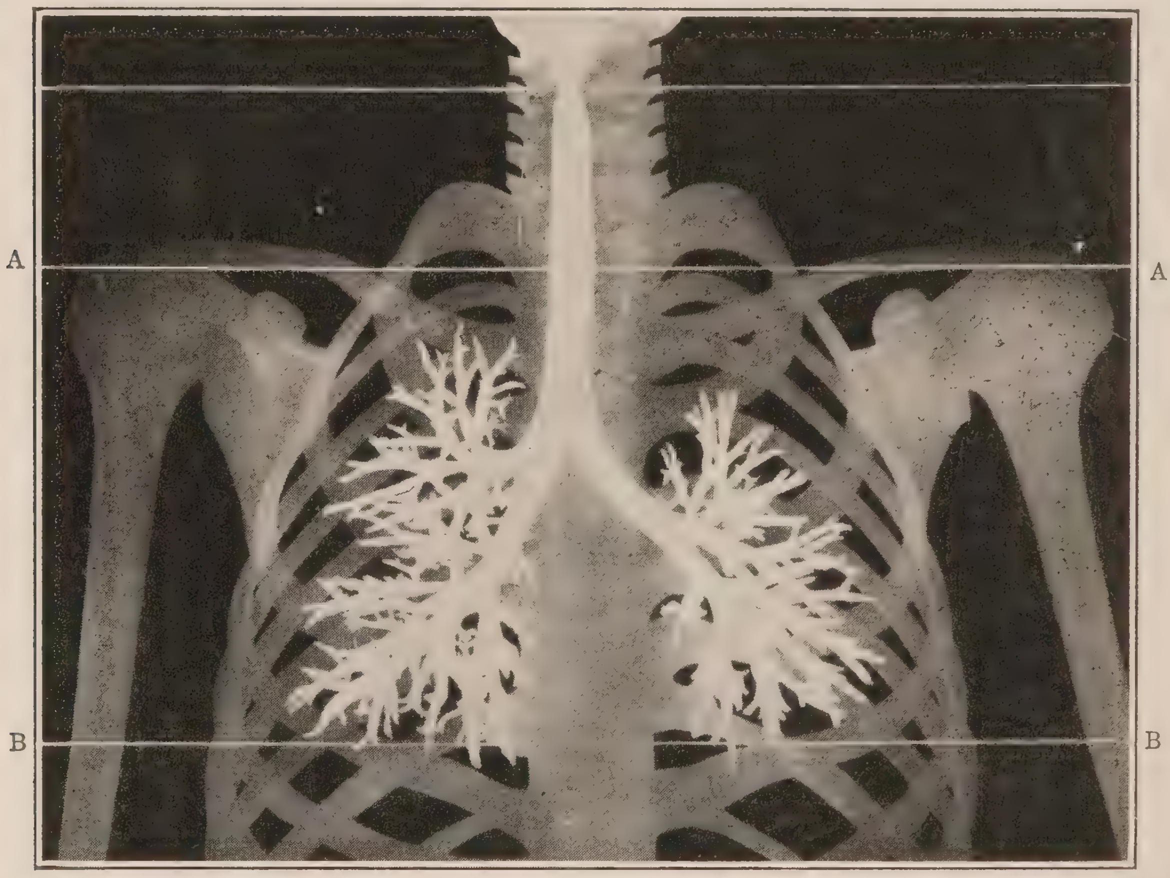


Fig. 208.—Chevalier Jackson's transparent positive films of the tracheobronchial tree. When placed over the negative of the patient the foreign body, (strengthened with ink if necessary) shows through, revealing its location in the tree. The lines *A*, representing the pleural dome and *B*, the diaphragmatic dome are used, instead of bony landmarks. (*Jackson.*)

Bronchoscopy is indicated in every case of foreign body in the trachea and bronchi, and there are no contraindications. Should bronchoscopy fail, thoracotomy is indicated because the intruder will ultimately prove fatal and the chances of its being coughed up are so remote that it is unwise to take the risks involved in the secondary processes. There are, however, a number of cases in which foreign bodies have been present in the lungs for prolonged periods without being fatal though the patients were all *in extremis* from the prolonged suppuration. The author had one case in which a tack was present for two years, another in which a lead collar button was present for 10 years, another in which a price tag fastener was present for eight years, and one case in which a glass collar button had been in the lung for

26 years. In all of these cases the intruder was removed by bronchoscopy through the mouth and the patients all recovered health. But the statistics collected in the prebronchoscopic days show clearly that foreign bodies are almost always ultimately fatal and usually within a period of from one and one-half to two years.

Bronchoscopy for Foreign Bodies.—Of the author's last 182 consecutive cases the foreign body was removed in 177. Of the five failures to remove foreign bodies known to be present, all were failures to find a small foreign body that was in a small branch bronchus close to the periphery of the lung. Of the 182 cases there was a total of three deaths (1.7 per cent.) from any cause whatever within one month, though a few cases could not be followed this long. None of the fatalities was due to the procedure of bronchoscopy itself. All of the bronchoscopies were done bloodlessly through the mouth. The phenomenal success of bronchoscopy renders any other procedure inadvisable until bronchoscopy has failed.

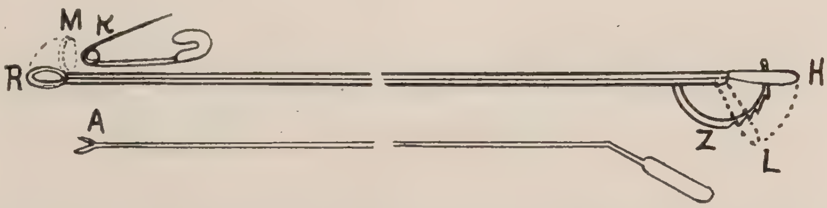


FIG. 209.—The author's safety-pin closer. The closer is passed under ocular control until the ring, *R*, is below the pin. The ring is then erected to the position shown dotted at *M*, by moving the handle, *H*, downward to *L* and locking it there with the latch *Z*. The fork, *A*, is then inserted and, engaging the pin at the spring loop, *K*, the pin is pushed into the ring, thus closing the pin. (*Jackson.*)

The method of introduction of the bronchoscope is elsewhere herein given. Having found the intruder by means of the bronchoscope the mechanical problem of its location must be studied and removal devised on a plan that will render injury to the bronchial tissues impossible. Pointed objects such as pins must have the point dislodged and brought within the tube-mouth before any attempt at extraction is made. Dislodgement is usually accomplished by pushing downward with forceps, the lower extremity of the foreign body being guided into a branch bronchus. Safety pins should be closed before removal, with special instruments that have been devised for the purpose (Fig. 209). A very ingenious closer on the tube-mouth has been devised by Mosher, who also devised the first ring form of closer. Transfixed objects must have one point depressed and then have the other point disengaged by counterpressure with the lip of the bronchoscope while gentle traction is made with the forceps. Special rotation forceps have been devised

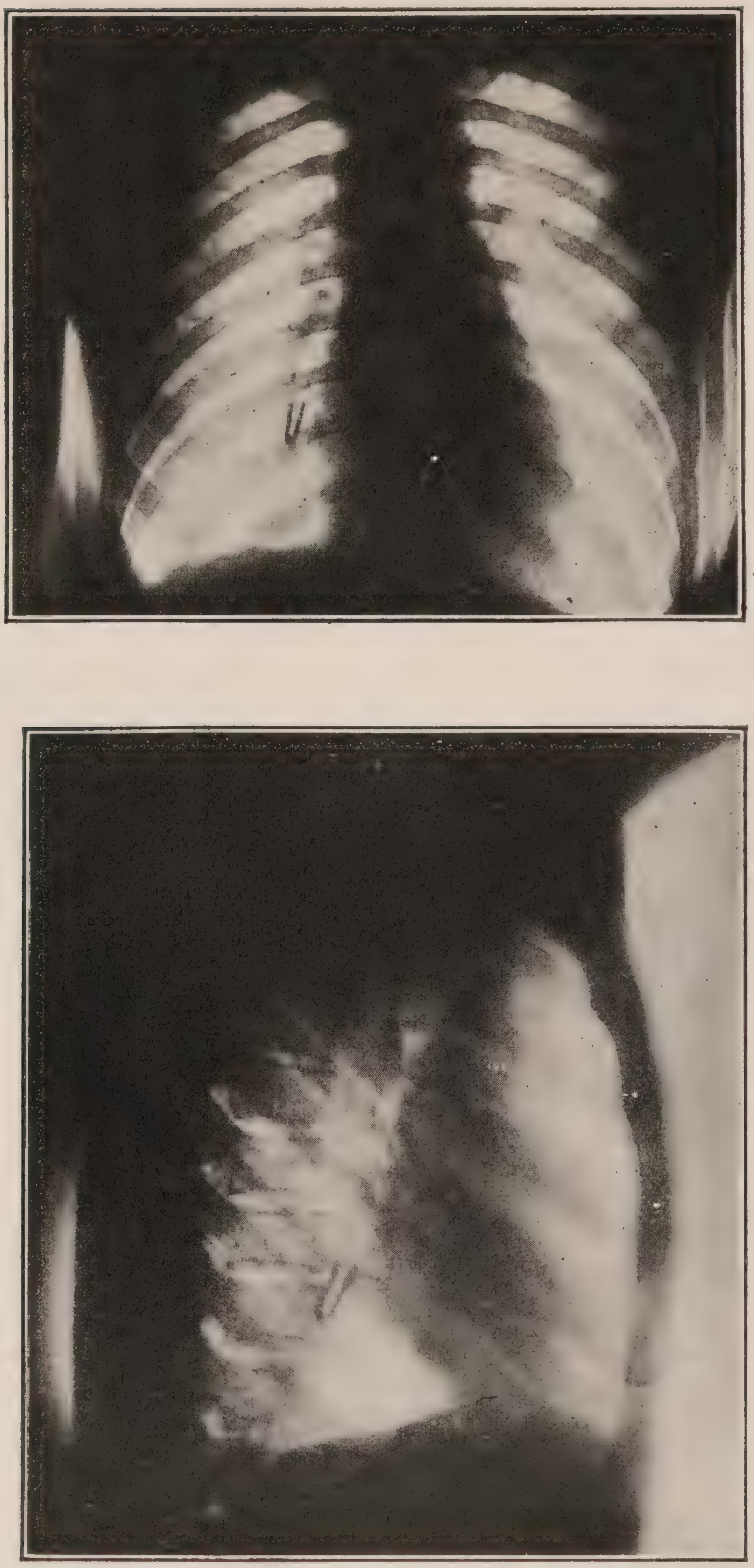


FIG. 210.—Radiographs, lateral and anteroposterior showing staple in a small posterior branch of the inferior lobe bronchus of a man aged 35 years. Staple was turned and removed bloodlessly through the mouth by bronchoscopy, under local anæsthesia. (*Author's case. Radiographs made by Johnston and Grier.*)

by the author for this purpose. Under no circumstances should a body be grasped when first seen and violently pulled upon, as fatal trauma may result. Bodies too large to be removed through the bronchoscope are removed by withdrawing the forceps, bronchoscope and foreign body all out together; but before doing so it is necessary to be certain that there are no projecting points in such position as to injure the tracheo-bronchial wall. Double-pointed tacks and staples, when lodged point upward, as they usually are, must never be pulled upon as fatal trauma would be certainly inflicted by the points ripping into the bronchial wall. They must be turned before removal. At the bifurcation is the widest place. In the case shown in Fig. 210 the staple was 4 in. below the bifurcation of the trachea and tightly wedged

FIG. 211.—Fence staple removed by bronchoscopy through the mouth from the location shown in Fig. 210.

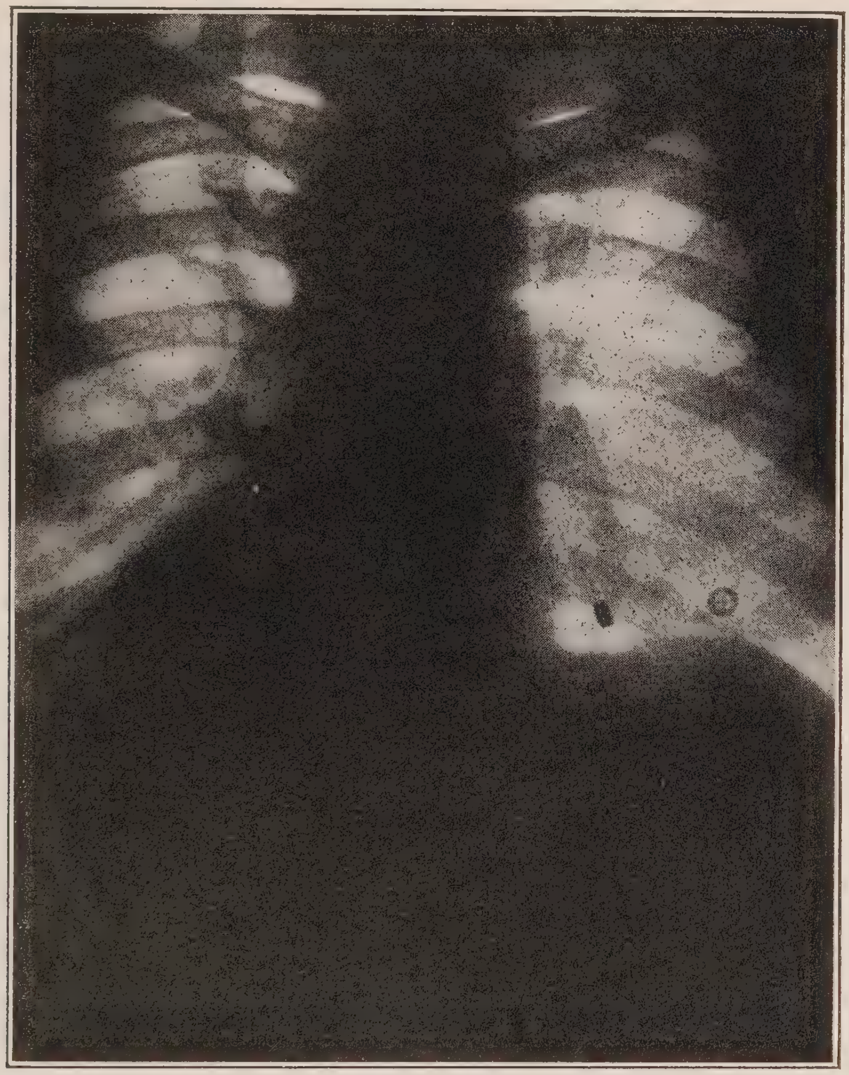


FIG. 212.—Dental instrument (broach) removed bloodlessly through the mouth by bronchoscopy under local anæsthesia from the right lung of a man aged 53 years. See radiograph, Fig. 213. (*Author's case. Radiograph made by Johnston and Grier.*)

in a small bronchus. The author succeeded in getting the two points into a pair of suitably spaced branch bronchial orifices, thus permit-

ting rotation, and withdrawal with turning forceps grasping the round end, the points trailing harmlessly behind. Extreme depth of lodgment, as in the case illustrated in Fig. 112 requires a small bronchoscope because of the small size of the invaded bronchus.

For further detailed consideration of the mechanical problems connected with the bronchoscopic extraction of the manifold forms of foreign bodies, the reader is referred to the book, "Peroral Endoscopy and Laryngeal Surgery," by Chevalier Jackson.

The fluoroscope has occasionally been used for guiding the forceps in the removal of a bronchially lodged foreign body. Six deaths have been reported from injury thus inflicted. It can be successful only in cases that would be most easily removed by ordinary bronchoscopy.

FIG. 213.

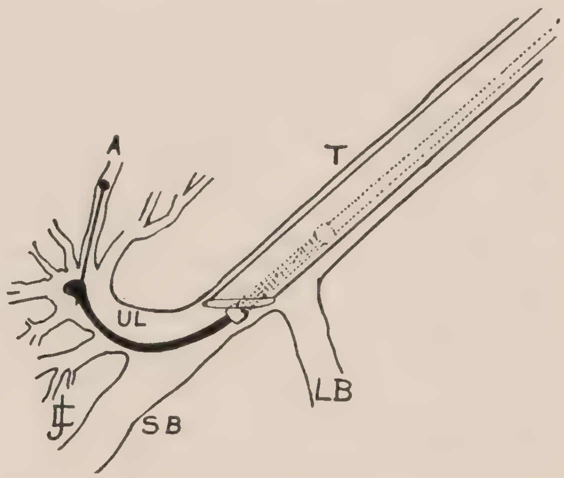


FIG. 214.

FIG. 213.—Radiograph of a dental instrument (broach) in a minute posterior branch of the right inferior lobe bronchus of a man 53 years of age. Removed bloodlessly through the mouth by bronchoscopy. (*Author's case.*)

FIG. 214.—The author's flexible-ended upper-lobe bronchus forceps for reaching "around the corner." The forceps are shown grasping a pin (A) in an ascending branch of the upper lobe bronchus (UL). S, stem-bronchus; LB, left main bronchus; T, trachea. (*Jackson.*)

There is a class of cases, however, in which the fluoroscope can be of great aid. In the cases of small foreign bodies far down and far out at the periphery in a minute bronchus too small to enter with the bronchoscope, the number of bronchi to be searched can be limited to a few by the advice given by the fluoroscopist who works with a combined vertical and horizontal fluoroscopic screen, devised for the author by Dr. George W. Grier. In using it the bronchoscopist works as usual through his bronchoscope and consequently is certain of doing no harm because he can see the action of his forceps and he is guided by directions such as "anteriorly, posteriorly and laterally." Thus he quickly locates the particular minute bronchus invaded and can explore it carefully with probe and forceps. This method is also useful for foreign

bodies "around the corner" in the upper lobe bronchus, using the author's special upper-lobe-bronchus forceps (Fig. 214).

Magnets have been used through the bronchoscope chiefly in two forms: one, a long magnet of small diameter, inserted through the bronchoscope; and the other a steel rod, introduced through the bronchoscope and energized by a very powerful magnet such as used by the ophthalmologists. The chief reason for failure is, as shown by the author, that the foreign body is seldom free to move, and the attraction of the magnet for the foreign body is no greater than the foreign body for the magnet. For this reason a very small body, which is the only kind that has not been found at bronchoscopy, is acted upon but very feebly. A foreign body as large as a railroad spike could be pulled out through the chest wall. Necessarily only foreign bodies composed partly or wholly of iron or steel are susceptible to magnetism.

INJURIES OF THE LARYNX

The larynx may be injured internally by foreign bodies, or by the finger in attempts to recover a foreign body, or by unskilful instrumentation such as in the effort to pass œsophageal bougies, probangs, œsophagoscopes, bronchoscopes, etc. Before the days of œsophagoscopy a common form of injury was with the Graefe basket in the effort to pass it into the œsophagus for a foreign body. On withdrawal, it would denude the cricoid cartilage, or even eviscerate the larynx, if, as sometimes happened, it had entered the larynx instead of the trachea. External forms of injury are caused by hanging, cut throat, garrotting and by falls on the neck. Suicidal attempts are usually too high to sever very large vessels. Stab wounds may be fatal from hemorrhage. In either case the chief dangers are from hemorrhage, suffocation by aspirated blood, and entrance of air into veins. The secondary dangers are from acute œdematous stenosis of the air passages, sepsis, cellulitis and perichondritis with chondrial necrosis. Ultimately, injury to the larynx is very prone to result in stenosis from cicatricial contraction or from loss of cartilage upon whose stiffness the open lumen depends. Cartilage about the air passages, in healing, is always associated with exuberant fungating granulations which produce stenosis, retard healing and build up a mass of cicatricial tissue.

Treatment.—After the arrest of hemorrhage, the first step should always be to examine the larynx by direct or indirect laryngoscopy in order to ascertain the presence of œdema. If present, tracheotomy should be done early rather than late. The tracheotomy should be

low. In external wounds of the larynx, hemorrhage should be arrested, clots removed and the parts cleansed with an antiseptic solution, taking great care to remove particles of clothing or other foreign matter. The deeper structures should be closed with catgut, silver wire or tendon sutures, silkworm-gut being used for the superficial stitches. Quite often, in cut-throat wounds especially, the whole wound will break down and suppurate, the stitches sloughing loose. In this case it is better to pack the wound, and re-dress every hour or two. It will usually be necessary in these cases to insert an intubation tube of large size in order to prevent stenosis from malposition of the cartilages and cicatricial contraction. The intubation tube should be removed at least every other day for cleansing and replacement. It should be introduced through the mouth as mentioned under laryngostomy. Feeding should be by soft rubber tube for the first week because food is very apt to get into the larynx and escape into the wound. If this occur, in spite of precautions, it is necessary to change the dressings at once after each feeding.

Fractures of the Larynx.—Fractures of the laryngeal cartilages may occur from any form of external violence. Fracture of the hyoid bone may be associated. Fractures occur only in adults, and especially after partial ossification of the cartilages. It is usually the thyroid cartilage that is involved. The external perichondrium may or may not be ruptured. The mucous membrane of the interior is rarely torn. The local symptoms are pain, tenderness and swelling with bloody expectoration if the mucous membrane has been torn. If the external perichondrium is ruptured, emphysema of the neck follows and extends to other regions. Laryngoscopic examination may show spots of ecchymosis and œdema. A positive diagnosis can be made only by the elicitation of crepitus or by a radiograph. Negative results of these must not be given too much weight. The prognosis is always serious, though doubtless it would be very much less so if tracheotomy were always done as a precautionary measure. Most of the deaths have been from the sudden onset of obstructive dyspnœa, from œdema or displacement of a portion of cartilage, the other and rarer causes being shock, emphysema of the mediastinum, bronchopneumonia, and septicemia. Stenosis from deformity or cicatricial contraction is a frequent result.

The best *treatment* is tracheotomy and, in the author's opinion, this should be done in every case in which a diagnosis of fracture can be made, regardless of whether obstructive dyspnœa is present or not, be-

cause of the frequently sudden onset of asphyxia. Intubation is unreliable though it will probably be required later after tracheotomy to prevent stenosis of the larynx from misplaced cartilages. This use of an intubation tube as an internal splint is better at this acute stage than the operation of laryngostomy because the incision required in laryngostomy or thyrotomy may make islands of cartilage out of the fragments with consequent increased tendency to stenosis. The intubation tubes will be referred to in a subsequent paragraph on stenosis. Later, for the treatment of sequential stenosis, laryngostomy is curative in almost every case. Laryngeal cartilages rarely, if ever, unite with cartilaginous or bony tissue. The union is always fibrous and is seldom rigid.

INJURIES OF THE TRACHEA

Injuries of the trachea may result from any form of external violence. They are relatively rare because of the extreme resiliency and mobility of the trachea. Penetration by cutting edges and splinters in wrecks, or by missiles and weapons in homicidal and suicidal efforts are not uncommon. Healing cartilage is prone to be associated with exuberant granulations, retarded healing, and consequent inflammatory infiltration with sequential stenosis from cicatricial contraction and cartilaginous deformity and deficiency.

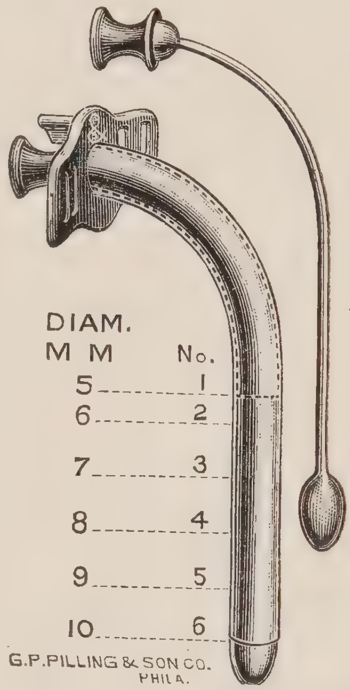


FIG. 215.—Chevalier Jackson's cane-shaped tracheal cannula for compression and other stenoses in the lower trachea. They reach to the bifurcation. There are six sizes, each with its own pilot.

Treatment.—The primary indication in all injuries to the trachea is to insert a tracheotomic cannula and this should be in all cases long enough to reach far below the injury. The author's cannulæ (Fig. 215) are long enough to reach to the bifurcation of the trachea. They may be shortened as needed for the particular case though there is no harm in using the full-length tube, which should in all cases be worn until complete healing and cicatricial contraction has taken place. For the insertion of a tracheotomic cannula it is usually necessary to make an incision rather than to utilize any of the accidental wounds that may be present. In making the incision it is necessary to avoid leaving an island of cartilage that will die. The lumen of the trachea should be inspected frequently with the bronchoscope, both above and below

as well as at the site of injury, in order to make sure that healing is progressing properly.

Mediastinal Emphysema.—The most frequent complication is mediastinal emphysema. If the mediastinum be not infected, the long tracheal cannula to the bifurcation will prevent asphyxia until the leaks are obliterated by inflammatory processes and until the air has been absorbed. These long tracheal cannulæ have enabled the author to save a number of cases of mediastinal emphysema which would otherwise have resulted fatally.

INFECTIVE DISEASES OF THE LARYNX AND TRACHEA

The infections having surgical significance are "influenza," diphtheria, tuberculosis and syphilis. In most instances the damage to the larynx which requires the surgeon's attention is due to the mixed pyogenic infections complicating these specific infections. Inflammation from any cause may set up an œdema resulting in an acute stenosis requiring tracheotomy. Later perichondritis, from involvement either by the specific or the mixed infections, produces conditions of chronic stenosis due to infiltration, chondrial necrosis, or cicatricial contraction. Œdema may also result from the administration of potassium iodide and where this is given for a luetic lesion of the larynx special watchfulness is obligatory.

Œdema of the larynx may occur from the acute laryngitis due to the so-called "cold," influenza, measles, scarlatina, typhoid fever, and in

FIG. 216.—Knife for use through the direct laryngoscope. (*Jackson.*)

acute and chronic nephritis. Multiple puncture by means of the direct laryngoscope (Fig. 198) and the long laryngeal knife (Fig. 216), is valuable in treatment but as a rule it is much safer to do a tracheotomy at once as the onset of fatal dyspnœa is apt to be sudden and tracheotomy is curative anyway. Intubation is not to be relied upon for any cases except those associated with diphtheria.

Diphtheria.—The larynx may be occluded by œdema, the swelling of perichondritis, or accumulated exudates. If an expert intubator is at hand constantly for replacement in the event of the tube being coughed out, O'Dwyer's intubation is ideal for the acute laryngeal stenosis of diphtheria; otherwise tracheotomy will be the safer pro-

cedure. The tracheal incision should be as far below the larynx as possible. Post-diphtheritic laryngeal stenosis may be hyperplastic, ankylotic, paralytic or cicatricial. The treatment of these is given in connection with stenosis of the larynx.

Tuberculosis of the larynx unless relieved, usually hastens the fatal termination of phthisis, because it diminishes the patient's respiratory air-supply and because the associated odynphagia interferes with proper nutrition. Relief, therefore, is imperative. If the pulmonary condition is not too far advanced, the larynx will be benefited by tracheotomy, provided the patient will live outdoors, to which the tracheotomy is no contraindication. Infiltration of the larynx is very rapidly reduced by multiple galvanopuncture through the direct laryngoscope (Fig. 198), by means of which it can be done with extreme accuracy and perpendicularly to the involved surface. Should the patient recover from the pulmonary condition, stenosis of the larynx can be relieved by methods hereafter mentioned.

Syphilis of the larynx, owing to the ravages of the mixed pyogenic infections, may require tracheotomy for acute or chronic stenosis. No local treatment beyond tracheotomy should be undertaken until a long course of treatment has completely mastered the basic disease. The relief of stenosis should be undertaken provided there is not too great loss of the cartilages upon which patency of any lumen must depend.

Syphilis of the Trachea.—Any of the tracheal cartilages may be involved in a luetic lesion. Usually it is an extension of a similar lesion in the larynx. Prompt and energetic systemic therapeusis is necessary to check the ravages before the cartilages have been extensively destroyed by the mixed infections which complicate syphilitic processes. Locally the indications are for early tracheotomy with the use of the long tracheal cannulæ (Fig. 215) to maintain an ample lumen, temporarily, to prevent asphyxia and, for a long time, to prevent ultimate stenosis.

Tuberculosis of the Trachea.—Tuberculosis of the trachea as a primary condition is very rare. It is also rare as a complication of pulmonary trouble. Nearly all cases are associated with tuberculous lesions in the larynx of which the tracheal lesions are an extension. Whether independent of laryngeal disease or not, the treatment is the same. The regular antituberculous régime, consisting of rest in bed out of doors, 23 hours out of 24, sunshine, milk and eggs, is curative. Locally it is necessary to guard against asphyxia by early trache-

otomy and the use of the long tracheal cannula (Fig. 215). These cannulæ can also be used to prevent stenosis after the tuberculous process has healed. If stenosis results from cicatricial contraction and extensive chondrial necrosis, the operation of laryngotracheostomy will cure. (See "Laryngostomy.") In the event of the bursting through of a tuberculous gland into the mediastinal trachea or into one of the bronchi, the bronchoscope should be used for the scooping out of the cheesy material. In the bronchi, stenosis does not ordinarily follow such a tuberculous process. If there should be any tendency to stenosis, bronchial intubation can be carried out through the bronchoscope. In case of a mass of tuberculous glands producing a compression stenosis of the trachea, the long tracheal cannula (Fig. 215) will render good service.

Leprosy of the Larynx.—Leprous involvement of the larynx does not occur independently but is not infrequently associated with the general manifestations. While the cause of leprosy is generally attributed to the constantly present acid-fast bacilli that closely resemble the bacillus tuberculosis, yet no therapeutic results have been obtained from any method of treatment based thereon. Tracheotomy may be needed for stenosis.

Scleroma of the larynx and trachea may cause stenosis. Tracheotomy is the best treatment. The Röntgen ray and radium have yielded good results (Emil Mayer) applied through the direct laryngoscope or the tracheotomic wound.

Typhoid Fever.—Œdema, ulceration and perichondritis, either separately or combined, may occur during the defervescence or convalescence of typhoid fever. The primary lesion may be a thrombosis or an infection by the typhoid fever bacilli or it may be a mixed pyogenic infection occurring at the site of a slight abrasion in a patient rendered vulnerable by the typhoid toxæmia. In any event, it is the pyogenic mixed infections which do the damage. Oral antisepsis with 25 per cent. alcohol and frequent brushing of the teeth are the best prophylactic measures. Tracheotomy should always be done early without waiting for dyspnœa. A patient may die from laryngeal stenosis without a fight for air.[1]

Pus collections should be drained early. The vapor of compound tincture of benzoin evaporated from boiling water in the room is beneficial. The laryngeal lesion is almost never fatal of itself if a trache-

[1] Chevalier Jackson. The Larynx in Typhoid Fever. American Journal of the Medical Sciences, November, 1905.

otomy be done. A greater or less degree of stenosis is apt to follow owing to loss of cartilage. This stenosis should be treated by prolonged intubation or laryngostomy as elsewhere described.

BENIGN TUMORS OF THE LARYNX

Infective granulomata associated with lues and tuberculosis are dealt with under these subjects. Inflammatory infiltrations at times

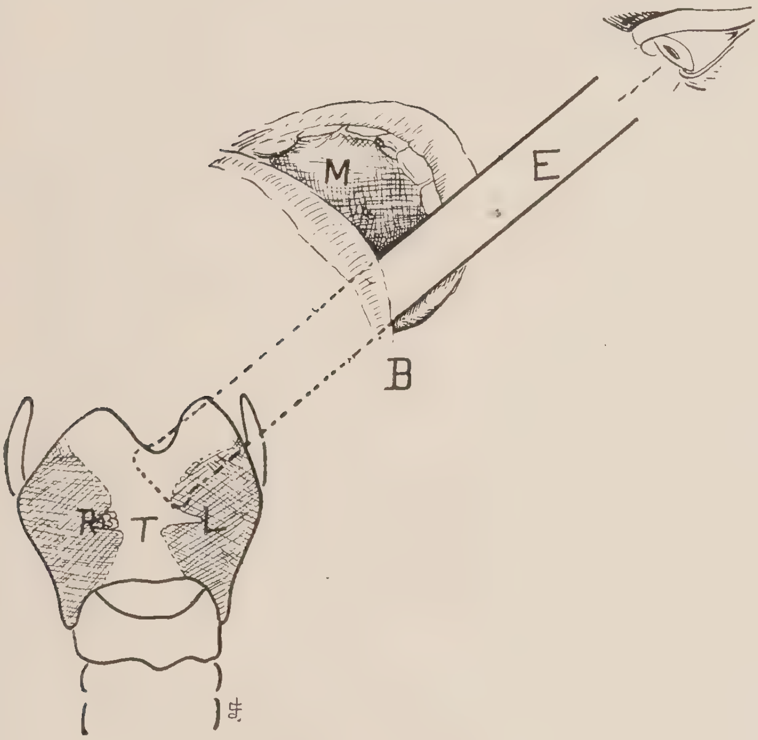


FIG. 217.

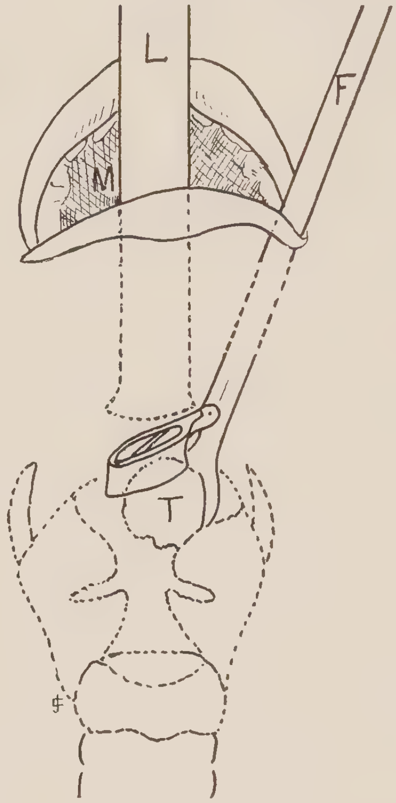


FIG. 218.

FIG. 217.—Schema illustrating the author's lateral method of exposing a growth in the ventriculus laryngis, by bending the patient's head to the opposite side while the second assistant fixes the larynx with his fingers. *M*, patient's mouth. *T*, thyroid cartilage. *R*, right side, *L*, left. The tube, *E*, should be brought down into the corner (*B*), of the mouth. (*Jackson.*)

FIG. 218.—Schema illustrating removal of a tumor from the upper part of the larynx by the author's "ex-tubal" method for *large* tumors. The large alligator basket punch forceps, *F*, is inserted from the right corner of the mouth, and the jaws are placed over the tumor, *T*, under guidance of the eye looking through the laryngoscope, *L*. This method is not used for small tumors. For still larger tumors the heavy snare may be used instead of forceps especially in tumors so large that the base cannot be seen. (*Jackson.*)

assume tumor-like forms. In addition to these we have pachydermia, œdematous polypi, singer's nodules, and cysts, all of which may be considered benign tumors though really of inflammatory origin. Pachydermia and singer's nodules are usually amenable to hygiene, careful voice use, especially vocal rest, pure air and abstinence from tobacco. Severe cases, however, will require touching with the galvano-cautery

point used by the direct laryngoscopic method. Œdematous polypi and cysts are to be treated as given below for true neoplasms. Papilloma, fibroma, myxoma, fibromyxoma, and lipoma are of not infrequent occurrence in the larynx and all require surgical removal. A few of the older generation of laryngologists, such as Delavan, developed wonderful skill in the indirect laryngoscopic or mirror method of removal of tumors, using the mirror with its reversed image, and a bent forceps. It requires rare skill in the case of adults and cannot be used at all in the case of children. Thyrotomy or laryngofissure is no longer justifiable for the removal of benign growths in the larynx. It has been abandoned in favor of the direct laryngoscopic method (Fig. 202). With practice, the greatest precision and accuracy are possible. It becomes necessary to decide whether the growth shall be sliced off even with the surface or whether a certain amount of normal base shall be removed. As a rule it may be stated that it is preferable to remove a small amount of normal base with all benign growths as this will prevent recurrence, except possibly in certain cases of papillomata which are considered below. The application of the galvano-cautery to the base is usually unnecessary. Tumors of the ventricle can be removed by the author's lateral method (Fig. 217). No matter how large the tumor it can be removed through the mouth by the author's extubal method (Fig. 218) thus rendering obsolete the operation of subhyoid pharyngotomy by substituting for this relatively serious operation the relatively minor one of direct laryngoscopy.

Papillomata require special consideration because of their great tendency to recurrence, especially in children. They are in a sense locally malignant though they do not infiltrate, simply repullulating on the surface. They spring up at new locations, seldom at the site of previous removal if the latter has been sufficiently deep to include about half the thickness of the mucosa. In time the surface of the mucosa becomes very superficially cicatricial, which makes a bad soil for the development of papillomata, and they cease to recur. By this method the author has been able to cure every case that has persisted in the treatment. Quite a number of cases get entirely and completely well without any sign of recurrence after a single operation. Many other cases, however, recur with great persistence after repeated removals. Thus it is clear that there are two classes of papillomata. Whatever method happens to be used in the type that is not followed by recurrence, is apt to be considered a superior form of treatment. Unfortunately the literature is filled with reports of cases shortly after

operation. No case can be pronounced well until a period of at least six months has elapsed without any sign of recurrence. Tracheotomy should be done for all cases that manifest the slightest dyspnœa during sleep at night. Tracheotomized cases will require careful watch lest a fragment of the papillomata, which have extended downward into the trachea, become detached and occlude the tube. A large number of cases have occurred where the child was found dead in bed in the morning from asphyxia following upon obstruction of the cannula, especially in small children who of necessity wear a very small cannula. Good results in preventing recurrences of papillomata have followed fulguration as advocated by Smith and also from the use of radium as advocated by Harris.

All forms of benign tumors of the larynx other than papillomata rarely recur, provided a shallow depth of basic normal is included in the removal. Cauterization is not necessary.

BENIGN TUMORS OF THE TRACHEA AND BRONCHI

The most common form of benign growth in this region is multiple papilloma extending from the larynx into the cervical trachea. Papillomata do occur also primarily in the trachea and bronchi but they are exceedingly rare.[1] Fibromata come next in frequency. Aberrant thyroid, lipomata, enchondromata, chondrosteomata, adenomata and lipomata occur in the trachea, though rarely, and still more rarely in the bronchi. Inflammatory tumors, especially œdematous polypi, are often associated with various morbid processes, and granulomata are not uncommon in connection with foreign bodies of prolonged sojourn.

The endoscopic removal of benign tumors of the tracheobronchial tree is a simple and easy procedure for anyone skilled in bronchoscopy. The growths are seized with tissue forceps (*E*, Fig. 198) and removed. The hemorrhage is of no consequence and only local anæsthesia is required for adults. For children no anæsthesia whatever, either local or general, is used. In either instance any oozing that may occur is readily coughed up and does no harm. General anæsthesia might permit the accumulation of blood in some of the smaller bronchi which, on breaking down, might produce complications. For similar reasons morphine or any other antibechic should not be given after operation. No anodyne is needed for there is no pain, either during or after the operation.

[1] Chevalier Jackson. Peroral Endoscopy and Laryngeal Surgery.

MALIGNANT TUMORS OF THE LARYNX

Malignant disease of the larynx occurs most frequently as a squamous-celled epithelioma. Sarcoma is relatively rare. One case of endothelioma has been reported.[1]

Diagnosis.—The differential diagnosis between the various forms of malignant tumors, and between tuberculoma, luetoma, and the chronic granuloma associated with necrosis of cartilage, usually following trauma, on the one hand, and the various forms of malignancy on the other, can very rarely be made on clinical appearances. Reliance must be placed upon biopsy, the Wassermann, luetin and tuberculin tests and the therapeutic test with mercury and potassium iodide. For the bioptic report to be reliable the specimen must be large and must include an area of basic normal. Where the tumor is small it is better to remove it entirely, including a portion of the apparently normal base. For this purpose direct laryngoscopy (Fig. 202) is the only reliable method because of the great precision with which the work can be done. The technique of removal of a specimen will be understood from the description in previous chapters relating to direct laryngoscopy and to benign tumors. Should the bioptic report indicate malignancy, in a case where direct laryngoscopic removal has entirely removed a small growth, further and more radical procedure will depend on the histologist's opinion as to the completeness of removal, with a sufficient base of normal.

Prophylactic Treatment.—The consensus of opinion among surgeons is in favor of a certain precancerous condition at the site of cancer. The author's case records afford abundant evidence that it is exceedingly rare for cancer to develop in a previously normal larynx. The history of almost every case of laryngeal malignancy indicates more or less annoyance referable to the larynx for so long a period of time that we cannot ignore the influence of chronic laryngitis as at least a predisposing cause of cancer of the larynx. In the author's opinion, specific ulcerations and benign growths, also, can prepare a soil more favorable than normal tissues for the invasion of cancer, and a rapid cure of any form of a curable laryngeal disease is a prophylactic measure.

Palliative Treatment.—The odor, which is largely due to the saprophytes, can be held in check by the local use of antiseptics and removal of secretions before there is time for decomposition. Hydrogen perox-

[1] Endothelioma of the Larynx, Chevalier Jackson, Pennsylvania Medical Journal, June, 1907.

ide in dilute solution as a gargle will help remove secretions and dilute alcohol (20 per cent.) is the most efficient non-toxic antiseptic. The peroxide solution should be used first, the alcoholic solution afterward. For pain, the insufflation of orthoform and menthol will postpone the resort to narcotics until the last stages. In dysphagia, seen especially in epiglottic and party-wall cases, intubation of the œsophagus will postpone gastrostomy until near the end. For odynphagia, due to malignant ulcer of the epiglottis, amputation of this structure by direct laryngoscopy has yielded excellent palliative results in the hands of Sir St. Clair Thomson and of the author. Dyspnœic cases should be tracheotomized early and as low in the neck as possible.

Curative Treatment.—Some day, doubtless, a therapeutic cure for malignancy will be discovered, but up to the present time nothing absolutely curative is known except early operation. In cases, however, that were inoperable, excellent results have been obtained by diathermy.[1] Excellent results from radium have been obtained by Ellen J. Patterson and others. In a case reported by Chevalier Jackson[2] a sarcoma disappeared under radium therapy and was followed by a squamous-celled epithelioma at the site from which the sarcoma disappeared. The Röntgen ray has also been used. Though with none of these procedures have the results been such as to warrant their use in any case deemed operable, yet the results in some instances have been so remarkable that they (especially radium) should be used in every inoperable case. As urged by Semon operability depends on early diagnosis.

No attempt at cure should be made in cases showing metastatic foci, organic disease, feebleness, alcoholism, pyorrhea alveolaris, or extensive suppurative disease of the accessory sinuses. Nor should any attempt be made in a case which, by its rapid progress or by the laboratory findings, has shown a very high grade of malignancy. Impossibility of entire removal by operation is, here as elsewhere, an absolute contraindication. If the lymph nodes cannot be removed, operation is out of the question, and even if the nodes can be removed operation is contraindicated unless the infected lymph channels by which the cancerous process has reached the nodes can also be extirpated.

Choice of Operation.—In early intrinsic malignancy of very limited extent, not involving the posterior portion of the larynx, the results of thyrotomy have been positively brilliant. Nowhere else in the whole

[1] Mr. W. Douglass Harmer. Diathermy in the Treatment of Inoperable Growths of the Nose and Throat. Journal of Laryngology, Oct., 1914.
[2] Chevalier Jackson. Peroral Endoscopy and Laryngeal Surgery. Textbook, 1914.

realm of the surgery of malignant disease have such results been obtained as from thyrotomy in such cases. This has been abundantly proven by the statistics of Sir Felix Semon, who first demonstrated the efficiency of the operation, and his results have been corroborated by those of Sir St. Clair Thomson, Mr. Tilley, Dundas Grant, Chevalier Jackson and others. Unfortunately the general statistics of thyrotomy are valueless because thyrotomy has been done in cases absolutely unsuited for the operation. The larynx is abundantly supplied with lymphatics which freely anastomose with each other, but, instead of leading out of the larynx by many channels, they empty into two small nodes on each side without any anastomosis with the neighboring lymphatic system. To this peculiar lymphatic arrangement is due the success of thyrotomy in the hands of the few operators who have limited the opera-

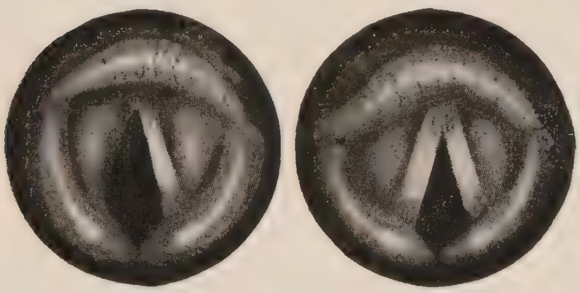


FIG. 219.

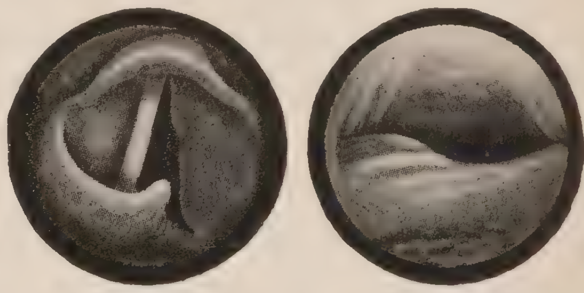


FIG. 220.

FIG. 219.—Indirect (mirror) view of larynx after thyrotomy for cancer of the right cord in a man of 50 years. The left-hand illustration shows condition eight weeks after thyrotomy. The right-hand illustration shows condition two years later. An adventitious cord indistinguishable from the original one has replaced the lost cord. (*Jackson.*)

FIG. 220.—The left-hand illustration shows an indirect (mirror) view of the larynx three years after hemilaryngectomy for epithelioma in a man 51 years of age. There is no attempt to form a new band because the arytenoid was (of necessity) removed. The right-hand illustration shows the lower pharynx and œsophageal mouth one year after laryngectomy for endothelioma in a man aged 68 years. (*Jackson.*)

tion of thyrotomy to properly selected cases. Sir Felix Semon had 76 per cent. of lasting cures, out of 22 cases. Sixteen of these cases were known to be well after periods varying from 3 to 16 years. Of Chevalier Jackson's 25 cases of thyrotomy for malignancy 22 patients were free from recurrence at the end of one year. Seventeen out of the 25 cases were well and free from recurrence after periods varying from 3 to 13 years. There was no operative mortality in 27 operations on the 25 patients. To offer hope of success from thyrotomy the growth must be of very small extent, the party-wall must be free from involvement and the growth must be intrinsic; that is, located below the upper edge of the ventricular band, or, more specifically, upon the vocal cords, the ventricles, ventricular bands, the interarytenoid region or the subglottic area. In cases in which the involvement is extrinsic (located

above the upper border of the ventricular band) or has extended beyond the limits of the larynx, either into the neck or backward into the party-wall, laryngectomy is indicated provided the deep lymphatics along the œsophagus are not involved down into the mediastinum. This can usually be determined by œsophagoscopy. The operation of laryngectomy has been freed from a large part of the operative mortality which attached to it in the preaseptic days. Of 14 laryngectomies done by Chevalier Jackson, two died within 30 days, giving an operative mortality of 14 per cent.; four died within a year of local recurrence; three lived one year and were thereafter lost to observation; two lived two years, dying of recurrence; one two and one-half years, dying of recurrence; one three years, dying of cerebral hemorrhage; one seven years, dying of cancer of the stomach. Recapitulating this, of 15 complete laryngectomies, eight of the patients were free from recurrence at the end of one year, yet all are since dead and the average duration of life was but little over one year. The occurrence of cancer in the stomach seven years after laryngectomy must be looked upon as a re-infection, rather than a re-pullulation of the primary process. As stated by Delavan, it is questionable if the operation of total laryngectomy has added anything to the sum total of human life.

The relatively normal larynx after thyrotomy is shown in Fig. 219. This should be compared to the mutilated condition after laryngectomy as shown in Fig. 220.

Vocal Results after Operations on the Larynx for Malignant Disease.—After thyrotomy the patient can be assured of a loud and useful voice. In cases where the motility of the arytenoid has not been interfered with by the operation, as shown by the author, an adventitious band will be formed out of the cicatricial tissue, by the traction of the arytenoid, and the patient's voice will ultimately become as good as it was before the operation, having flexibility, modulation and even singing power. After the modern operation of laryngectomy, in which the trachea is stitched to the skin of the neck, the patient has a choice between a prothetic apparatus, called an artificial larynx, and the development of a buccal voice, which depends upon swallowed air. This buccal voice has been developed in some instances to a remarkable extent but at best the patient's condition after laryngectomy is pitiable compared to the condition after thyrotomy. It is to be hoped that the early discovery of malignancy of the larynx will, in the future, enable all patients with intrinsic laryngeal cancer to have the advantage of an early thyrotomy.

Preparation of the Patient for Laryngeal Operation.—Carious teeth should be filled or removed and the mouth should be put in as healthy a condition as possible by the dentist. Frequent brushings of the teeth with a good paste and frequent rinsings of the mouth with 25 per cent. alcohol will place the patient in the best condition to avoid the dangers of oral sepsis. The beard and moustache should be removed, if the patient have these, and the face should be freshly shaven on the morning

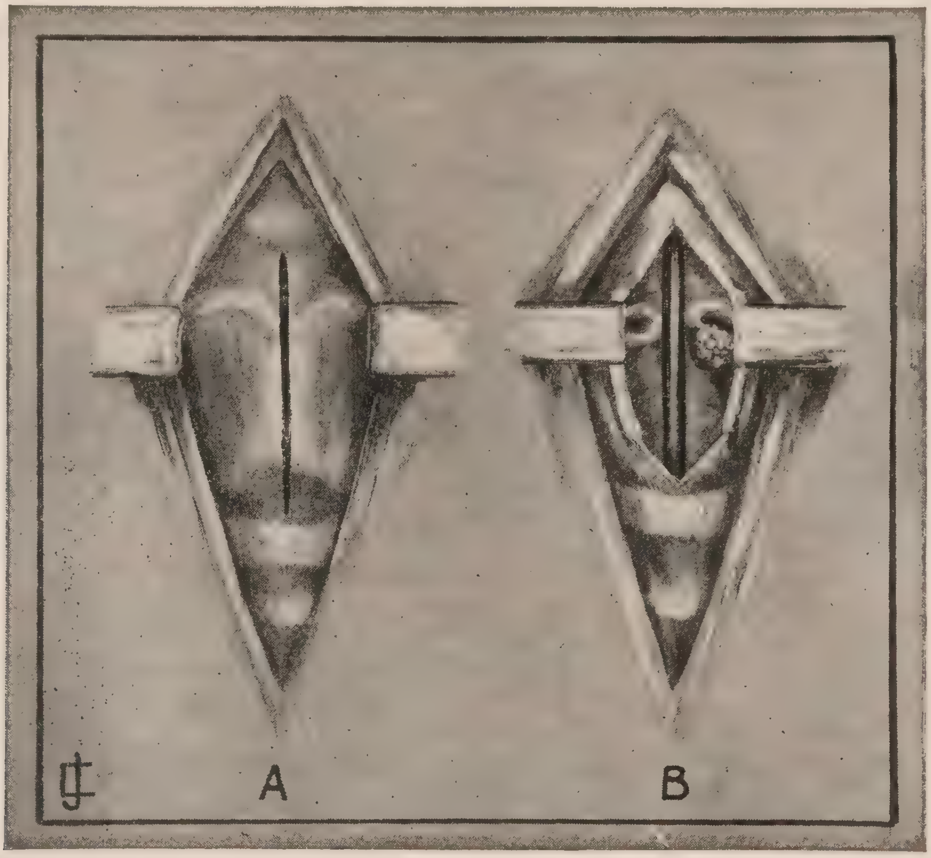


FIG. 221.—Illustration of thyrotomy or laryngofissure. *A*, shows the line of incision through the thyroid cartilage. The turbinotome is inserted at the cricothyroid membrane, the points passing upward. (Fig. 222.) *B*, shows retractors placed inside the larynx to hold back the wings of the divided thyroid cartilage. In the median line is seen the insufflation anæsthesia catheter. The growth is on the left vocal cord. Perichondrial dissection begins at the divided edge of the thyroid cartilage, the retractor being shifted to the bared cartilage as soon as sufficient perichondrium has been separated. (*Jackson.*)

of operation. The general preparation should be as for any other surgical procedure.

Anæsthesia for External Laryngeal Operations.—Local infiltration anæsthesia may be used if desired but the intratracheal insufflation of ether, originated by Meltzer and Auer, and developed by Elsberg, Janeway and others, affords so many advantages that it has superseded all other methods. As shown in Fig. 221, the catheter is not in the way in thyrotomy, and if it is desired to do laryngectomy, a fresh catheter is inserted below as soon as the larynx is drawn forward, or the trachea

is amputated, as the case may be. The return blast of air prevents all trickling of blood or secretions into the lungs.

Technique of Thyrotomy.—The patient should be placed on an inclined table with the head at the lower end, and a sand bag should be under the neck to render the larynx prominent. As shown in Fig. 221, the skin is incised from the level of the hyoid bone to about the level of the second ring of the trachea. An incision is then made in the cricothyroid membrane. It is usually better not to incise the cricoid cartilage. The turbinotome, as shown in Fig. 222, is inserted through the incision, the blades being guided upward until the outer blade is slightly above the thyroid notch. The thyroid cartilage is then divided at one clip.

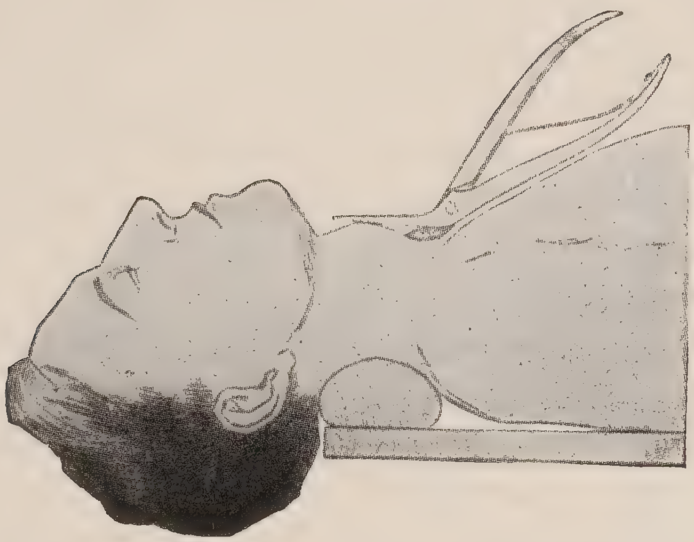


FIG. 222.—Turbinotome (see Fig. 221) in position to make the thyrotomic clip. The table is not shown steeply inclined toward the head as it should be before the turbinotome is inserted. (*Jackson.*)

The wings of the cartilage are spread with retractors. Upon exposure of the interior of the larynx, the growth is usually found to be more extensive than was anticipated, and the surgeon also notes that the vocal cords are not visible as white ribbon-like bands, as seen from above in the laryngeal mirror. The ventricle of the larynx, however, is always conspicuous as a depression, and it is only necessary to remember that the cord is the lower ridge of the depression. Excision of the growth is now commenced by starting at the anterior edge of the divided cartilage and dissecting to the inner perichondrium. The dissection is carried all the way around posteriorly sufficiently far so that the excised mass will be of normal tissue having in its center the growth as a small island. The external perichondrium must be kept intact or chondrial necrosis may result. Hemorrhage is usually slight but occasionally a vessel will require torsion, rarely ligation. The wound may be shortened vertically by a stitch or two at top and bottom, but the portion

corresponding to the incision of the thyroid cartilage should be left open. Under no circumstances should the cartilages be stitched, because the stitches are almost certain to tear out and more or less chondrial necrosis will follow. The wound must be kept packed open until good fibrous union of the wings of the thyroid cartilage takes place. It never becomes cartilaginous. In packing the wound it is necessary to use a large piece of gauze all over the front of the neck; and into this, at the site of the wound, a roll of gauze is forced, in order to keep the lips of the wound in the soft tissues separated. Under no circumstances should strings of packing be used lest they get into the trachea. All dressings should be wrung out of mercuric bichloride solution 1 : 10,000.

After-care.—As there is more or less air leakage through the wound and dressings, the secretions quickly become infected but the wound can be kept clean and free from pus by the use of moist bichloride dressings, 1 : 10,000, replaced not less often than every third hour night and day. No tracheal cannula is inserted, but a nurse competent to insert it in case it is necessary should be at the patient's bedside constantly and she should be competent to change the dressings. For the first 48 hours after operation the patient's head should be prevented from rotating by supporting it on each side with sand bags.

Complications.—Secondary hemorrhage is very rare but if it occur, the wound must be opened; and if the bleeding is found to be within the larynx, the wings of the thyroid cartilage must be separated with retractors and the bleeding points searched for and the vessel twisted. If no vessel can be located and the oozing continue, it may be necessary to insert a tracheal cannula below for breathing and then pack the larynx tightly full of gauze to arrest the oozing by pressure. In such a case the cannula should be abandoned as soon as possible, usually at the end of a few hours. Necrosis of cartilage with subsequent stenosis may result from denuding the cartilage of both inner and outer perichondria, or from the insertion of stitches, both of which are avoidable. In case of re-operation an island of cartilage may die if the line of fibrous union of the previous incision be not followed. Pulmonary complications are exceedingly rare when the technique herein given is followed.

Technique of Laryngectomy.—The preparation and position of the patient are all as given above for thyrotomy; and as there mentioned, intratracheal ether insufflation is the preferable method of anæsthesia.

Two classes of procedure have been followed for the removal of the larynx. In one (Keen), the extirpation begins above at the thyrohyoid

membrane, the larynx being drawn forward as it is separated from the party-wall; the amputation of the trachea is done when sufficient of the larynx and the trachea have been thus dissected loose and drawn out. The anæsthesia, which has been started by the open method, is now continued with an insufflation catheter inserted into the outdrawn larynx. The other method is used after preliminary tracheotomy. The trachea is divided below the cricoid, and the larynx is dissected away from the party-wall by working upward from below. Brewer, Crile and most American operators, prefer to do a preliminary tracheotomy about a week beforehand so as to permit firm adhesion between the trachea and the soft tissues of the neck to anchor the trachea firmly, thus avoiding the tendency to retraction within the thorax, when the trachea is afterward cut off and stitched to the skin. The inflammatory adhesions in the neighborhood of the trachea close various avenues by which infection could find its way into the mediastinum and this barrier can be increased as desired by blunt dissection around the sides of the trachea. A week or 10 days later the patient is preliminarily etherized with gauze over the tracheal cannula. Then the insufflation catheter is introduced through the cannula, in which it must not fit tightly. The trachea is amputated (as low as previous bronchoscopy has indicated) through a T-shaped incision of which the vertical portion extends from the neighborhood of the hyoid bone down as far as needed though preferably not extending into the preliminary tracheotomy wound. A transverse incision extending from one sternocleidomastoid ridge to the other is made at the upper extremity of the vertical incision. Two anchor sutures are placed as shown at A, B, Fig. 223. The lower end of the larynx which is then amputated from the trachea and raised as shown at 2, in Fig. 223, and very carefully dissected free from the œsophagus without undue traction. The vagi and parathyroids should be carefully avoided. One vagus and one parathyroid may be removed if involved but if both are found invaded it is better to abandon hope of cure. If much dissection of the larynx has taken place it may be necessary to amputate a portion, but in most instances it will be found better to replace the tissues as nearly as possible to their normal situation and close the wound, inserting a little drainage. If, however, the case has been well selected for laryngectomy there will not be involvement of the vagi or parathyroids, and the dissection may proceed rapidly without approaching the neighborhood of either the vagi or the parathyroids. Small snips with the scissors are used to separate the larynx from the œsophageal and pharyn-

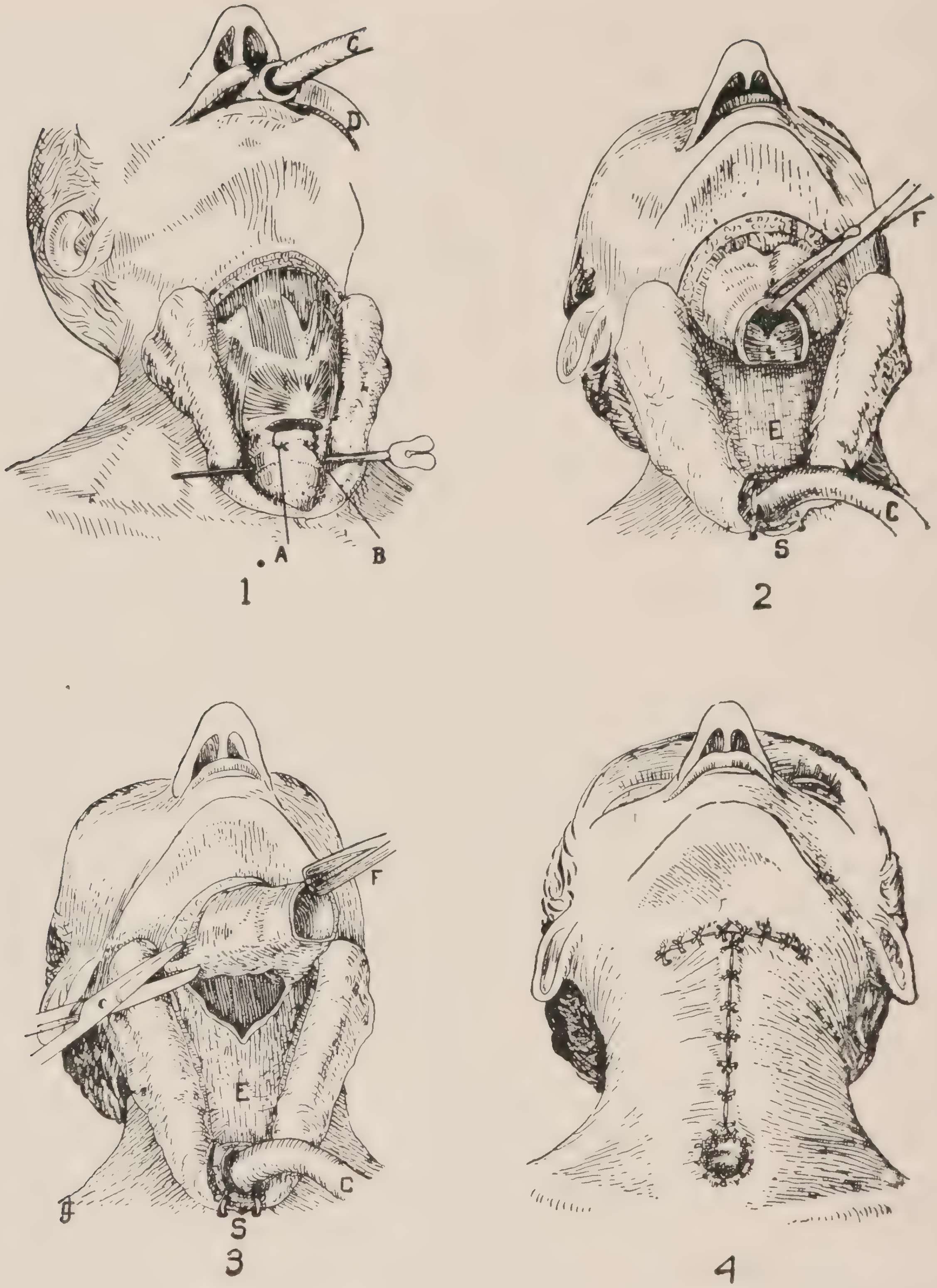


FIG. 223.—Schematic illustration of laryngectomy with the aid of intratracheal insufflation anæsthesia. At 1 is shown the trachea and larynx exposed during anæsthesia administered with the Elsberg apparatus through the silk-woven catheter, *C*, held in place with the Janeway bite block, *D*. The incision has been made of T-shape as will be understood by the sutured wound in 4. The trachea is elevated forward by means of the grooved director inserted carefully between the trachea and the œsophagus. Two anchor sutures are inserted around the first ring of the trachea as shown at *A*, *B*, after preliminary incision of the interannular membrane.

2. The trachea has been severed between the cricoid and the first ring, drawn forward, and firmly fastened with the anchor sutures (*S*). A fresh insufflation catheter (*C*) has been inserted for the continuation of the anæsthetic. The larynx has been dissected free from the œsophageal wall (*E*). The larynx is held forward with the forceps, *F*.

3. The scissors are shown dividing the cornu of the thyroid cartilage. The pharyngeal wall has been divided so as to free the larynx posteriorly and this clipping will be continued around over the front so as to free the entire larynx.

4. The wound is stitched together throughout its entire extent after suturing the pharynx, putting in supporting sutures, and securely anchoring the trachea to the skin (*Modified from Molinie*).

geal wall. As much of the latter must be preserved as possible. Usually the tips of the horns of the thyroid cartilage are cut off and left. The thyrohyoid membrane is incised and the aryepiglottic folds are clipped free with the scissors. All hemorrhage is carefully arrested at each stage of the procedure; a clean dry wound at each stage of the operation being essential to accurate work. The pharynx is sutured with silk, care being taken not to perforate the mucosa, the edges of which are inverted. Before the sutures are placed, each layer of soft tissue is carefully adjusted so as to afford the greatest possible support to withstand the strain of deglutition. Before stitching the skin, the insufflation catheter and cannula are removed. The trachea is brought forward by means of the anchor sutures and inserted in a button hole in the skin below the laryngectomy incision; or, if this incision has been so long as to extend into the tracheotomic wound, the cut end of the trachea is brought forward into the lower angle of the wound. In either case it is securely stitched all around the circumference of its upper ring. A tracheotomic cannula is inserted and a large dressing applied all over the front of the neck above the cannula. A separate piece of gauze is placed around the cannula as this part of the dressing requires very frequent removal. Dressings should be wrung out of mercuric bichloride 1 : 10,000. A few strands of silkworm-gut may be used for drainage but they should be removed as early as possible.

The most favorable time for the removal of lymph nodes in the neck is at the preliminary tracheotomy because a rather extensive neck dissection at that time has the advantage of forming a barrier against the infection of the mediastinum at the laryngectomy later, and if the glandular involvement is such that there is reason to believe that the mediastinal glands are also infected, it is better to abandon all hope of cure and leave the tracheotomy tube in place or not according to conditions. If there has been the slightest dyspnœa present at night, the tracheotomy will soon be required for palliation and it is better to insert the cannula at once. This exploratory operation at the time of tracheotomy will usually be rendered unnecessary if an œsophagoscopy has previously been done, because the lymph nodes in the mediastinum can be discovered by œsophagoscopy.

After-care.—Antibechics and all opium derivatives must be forbidden. Plenty of food must be given, especially liquids. The best method is by a soft rubber catheter or very small stomach tube passed through the mouth. In some instances it has been passed through the nose. The dressings over the wound in the neck must be changed every

third hour while the dressing around the tracheotomic cannula must be removed as often as soiled, in some instances as often as every few minutes. If the pharyngeal stitches give way and serious leakage into the neck wound occurs, it will be necessary to cut a number of the superficial stitches to permit free drainage of pharyngeal secretions, changing the dressings every hour or oftener if necessary. In such cases the wound may be freely irrigated by having the patient attempt to swallow sterile water which must be caught in a pan externally to prevent it overflowing into the trachea, where the latter is sutured to the skin. Usually the feeding tube may be abandoned and the patient permitted to swallow strained sterile food in small sips at the end of a week or 10 days. The patient should be propped up in bed on the second day and got out of bed on the fourth or fifth day.

Complications.—Operative complications are now much rarer than formerly. Pulmonary complications are avoided by the method of Solis-Cohen of stitching the trachea to the skin and by the use of the inclined position and the intratracheal insufflation anæsthesia. Sloughing of the œsophagus, vagitis and septic mediastinitis are indicated by profound shock, weak and rapid pulse, slight temperature elevation, and a white or ashy gray complexion out of all proportion to the usual post-operative reaction. Beyond stimulants and local drainage of necrotic areas, treatment is of little avail.

Glück's Method of Laryngectomy.—No preliminary tracheotomy is done. Instead of the T-shaped incision described above, a rectangular flap is formed by two horizontal incisions, one at the level of the hyoid bone and the other at the level of the third tracheal ring, the two being joined by a vertical incision at the left side of the neck (Fig. 226). This flap is raised and turned over to the patient's right, the flap including skin, subcutaneous cellular tissue and the platysma. This exposes the larynx and its overlying muscles, of which the sternohyoid and sternothyroid are divided both above and below, the section between being retracted laterally with its deeper attachment. The superior thyroid arteries are exposed and ligated. Then the larynx is denuded of all its attachments by blunt dissection which is carried around posteriorly so as to liberate the larynx from the œsophagus, but the trachea is not amputated. The thyrohyoid membrane is divided by a transverse incision close below the hyoid bone as the larynx is drawn forward. Its interior is painted with a 10 per cent. solution of cocaine and a cannula is introduced and attached by two sutures to the anterior tissues of the larynx. The upper laryngeal margin is now separated

from the pharyngeal wall with the scissors, being careful to preserve as much of the wall as possible. The larynx is drawn forward and freed from the œsophagus (Fig. 224). An incision is now made in the median line of the neck over the trachea down as far as the suprasternal notch. The thyroid isthmus is divided between ligatures and the larynx is amputated. The trachea is sutured to the skin of the neck as originally proposed by Solis-Cohen. The pharyngeal wall is then repaired (Fig. 225) with a double row of catgut sutures and reinforced by suturing

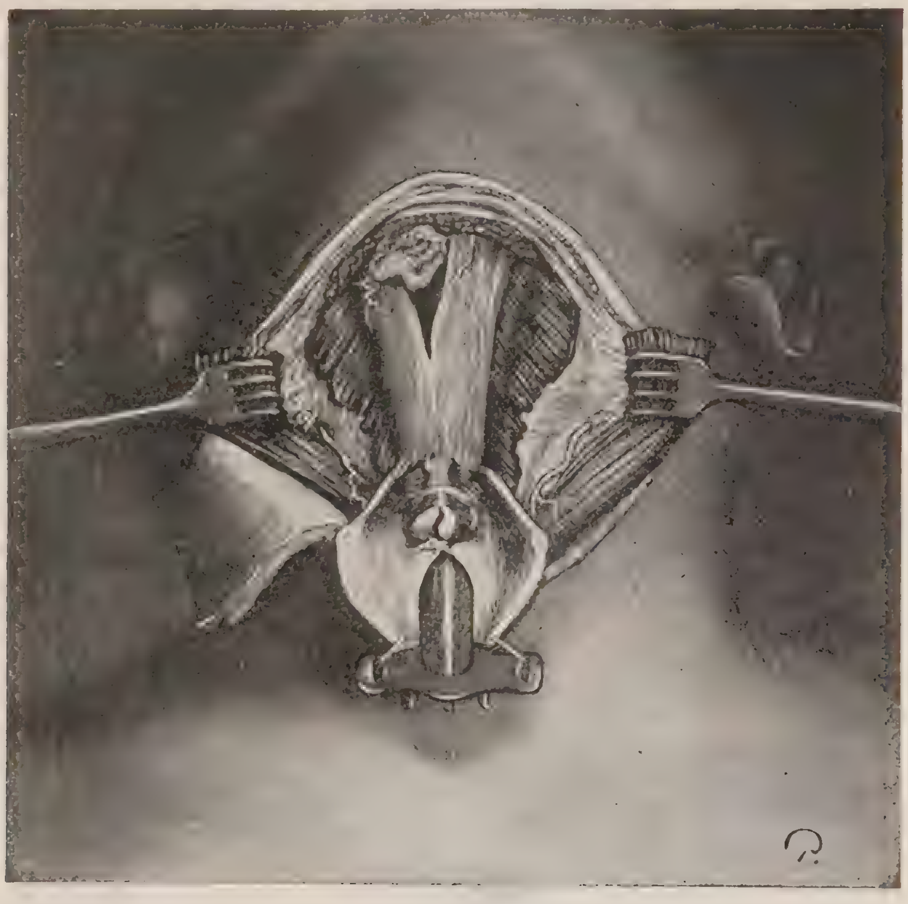


FIG. 224.—Glück's method of laryngectomy, second stage. Larynx drawn forward and freed from the œsophagus. (*Keen.*)

the retracted sternohyoid and sternothyroid muscles. The rectangular flap is then sutured in place except the vertical portion of the incision at the left side which is used for the insertion of a large gauze drain. (Fig. 226). Glück has not used the insufflation anæsthesia, as yet, preferring chloroform. A fresh insufflation catheter could be inserted as the larynx is brought forward, instead of inserting the tracheal cannula as mentioned above. The chief objection that has been raised by Crile and other American operators who have tried the Glück method is that the trachea, not being anchored by the inflammatory adhesions of a preliminary tracheotomy, is very prone to retract within the thorax, with, in some instances, necrosis of the tracheal rings. Septic

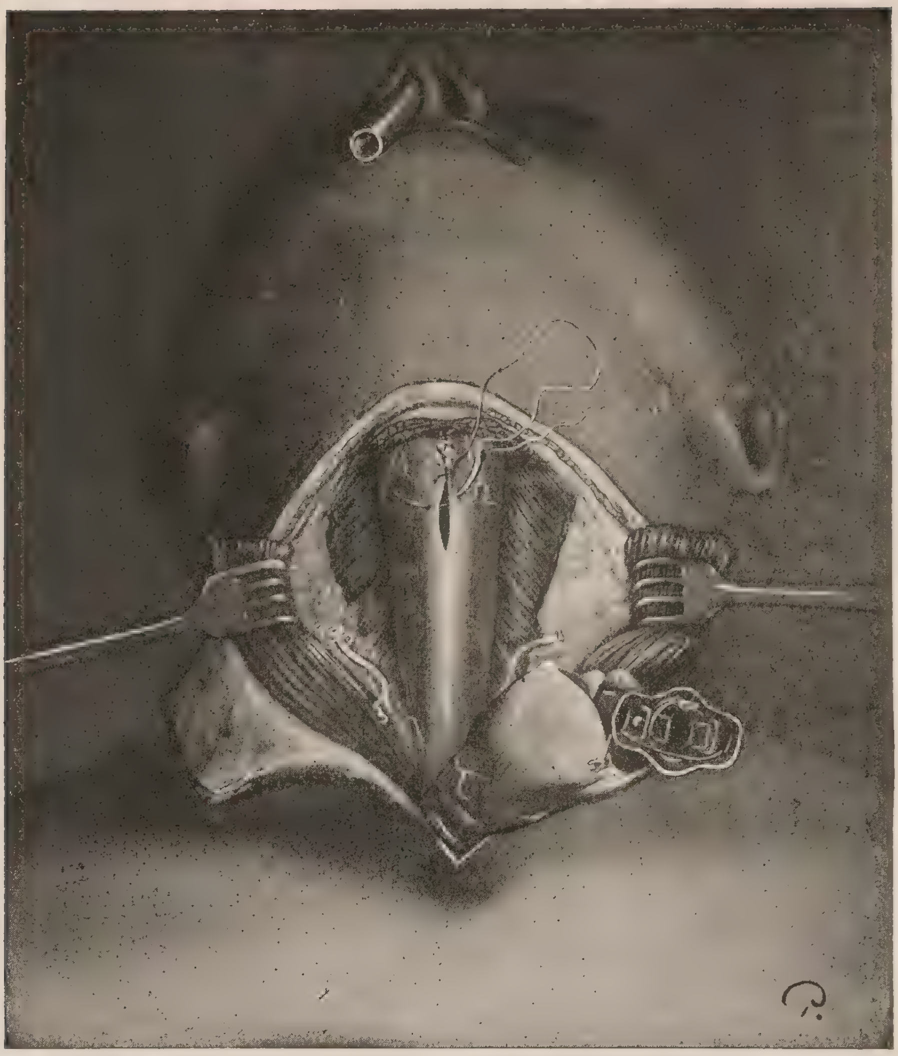


FIG. 225.—Glück's laryngectomy. Third stage. Wound in pharynx being closed by suture. (*Keen.*)

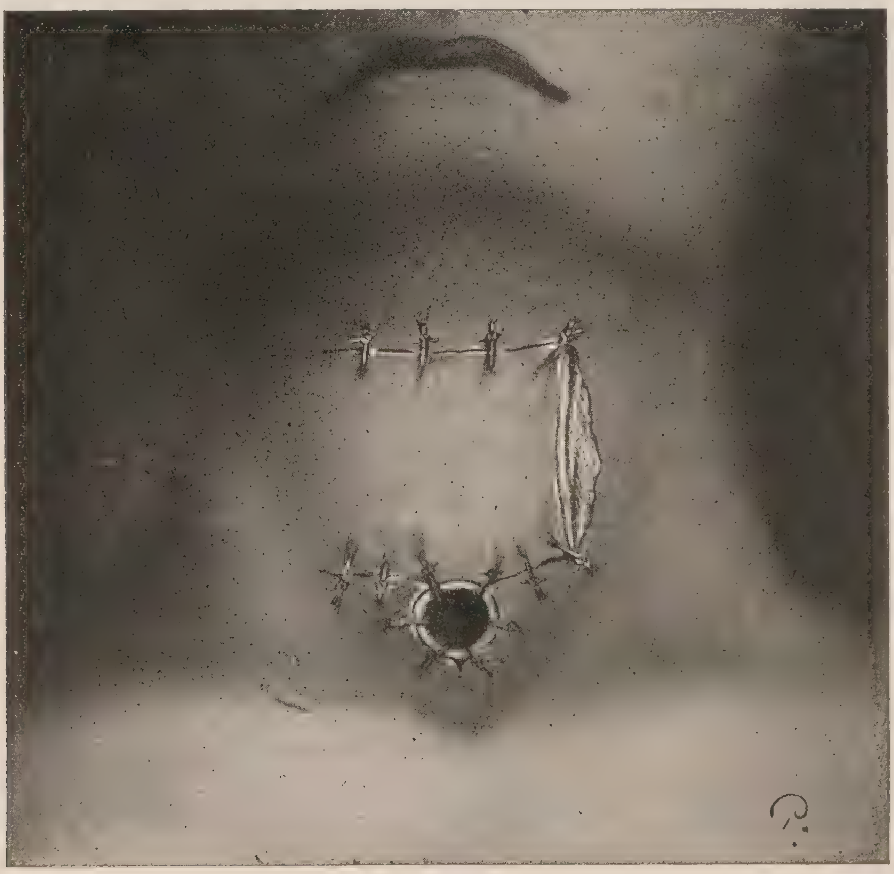


FIG. 226.—Glück's method of laryngectomy. Wound closed and drainage inserted. (*Keen.*)

mediastinitis is not so well guarded against as when a layer of inflammatory tissue is set up between the layers of cervical tissues.[1]

Malignant Tumors of the Tracheobronchial Tree.—Malignant growths primary in the tracheobronchial tree are rare. Usually malignancy here is seen as a compression stenosis or an extension from the neighborhood. The diagnosis is readily made with the bronchoscope, by means of which a specimen for biopsy is readily taken. Treatment by radium has caused amelioration but no cures. Operative treatment is elsewhere herein considered.[2]

DEFORMITIES OF THE LARYNX, TRACHEA AND BRONCHI

Congenital deformities of the trachea and bronchi are exceedingly rare. The least rare is the congenital tracheoœsophageal fistula usually associated with an impervious œsophagus. With rare exceptions the discovery has been made only after death.

Acquired stenoses of the trachea and bronchi are of relatively common occurrence and may be due to tuberculosis, lues, or to the secondary processes set up around a foreign body. The strictures may be dilated with the author's bronchial dilators, Fig. 227, used through the

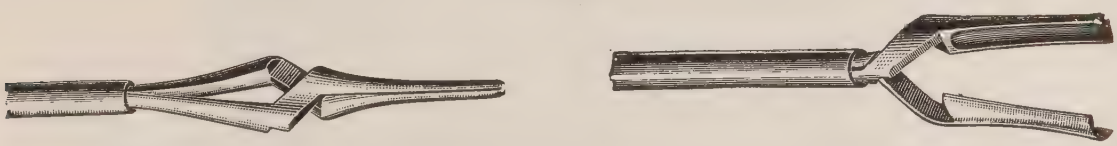


FIG. 227.—Bronchial dilators to fit the handle of the forceps shown at *D*, Fig. 198. They are used through the bronchoscope under guidance of the eye. (*Jackson.*)

bronchoscope. Luetic stenoses are usually very persistent in recurring and may require the wearing of a bronchial intubation tube which is placed *in situ* with the aid of the bronchoscope. These bronchial intubation tubes may be worn for months without causing ulceration but they require removal every few days for cleansing and they must not be used of too great size. When stenosis is of foreign body origin the foreign body will usually be found immediately below the stenosis from which location it can be removed after not unduly forcible dilatation. In these cases of prolonged sojourn of a foreign body a large quantity of pus and granulation tissue is first removed through the bronchoscope by the use of bronchoscopic sponges. When the foreign body is brought into view it is removed with bronchoscopic forceps, as mentioned on a previous page. Dilatation of the stenosis

[1] For review of statistics of many operators, see article by George E. Brewer, in Keen's Surgery, vol. vi, Chapter CXV, p. 364.

[2] For report of cure of an endothelioma by bronchoscopic removal see article on Bronchial Obstruction in Musser-Kelley's Handbook of Treatment, Supplementary Volume, 1917.

afterward is undertaken only when there are signs of lack of drainage, such as cessation of discharge, septic symptoms and radiographic shadow of pus accumulation. Of the author's eight cases of prolonged sojourn of a foreign body, all except one cleared up without after-dilatation.

Stenoses of the trachea of hyperplastic or cicatricial origin are, in many instances, amenable to the use of increasing sizes of the author's cane-shaped tracheal cannulæ, Fig. 215. In other cases the operation of laryngotracheostomy is required as will be described under the heading of laryngostomy.

FIG. 228.—From a photograph of a child, two years of age, taken six months after thymopexy. Diagnosis of thymic tracheostenosis made by bronchoscopy. Imminent asphyxia immediately and permanently relieved by thymopexy. (*Author's case.*)

Compression stenoses of the trachea may be due to peritracheal, malignant or benign growths. The author has demonstrated[1] that the thymus gland can and does compress the trachea in certain cases (Fig. 228). The degree of compression increases with congestion, thus mechanically causing death by thymic tracheostenosis, usually attributed to a hypothetical "hyperthymization of the blood," "status lymphaticus," etc. In a number of instances the stenosis has been congenital. The thyroid gland has in a number of cases produced such a severe

[1] Chevalier Jackson. Thymic Tracheostenosis, Tracheostomy, Thymectomy, Cure. Journal of the American Medical Association, May 25, 1907

stenosis that the patient would have been asphyxiated had not the cane-shaped tracheotomic cannula (Fig. 215) been inserted. Most of the author's cases of the latter class were of malignant goiter, in one case intrathoracic. In another instance a congenital goiter caused what would have been a fatal case of "blue baby" had not a timely tracheotomy been done.

The diagnosis is quickly made with the direct laryngoscope and bronchoscope.

FIG. 229.—Radiograph of a man, aged 50 years with an inoperable malignant substernal goitrous compression stenosis, the dyspnœa of which was completely relieved by the author's cane-shaped cannula shown in Fig. 215. (*Jackson.*)

The treatment of thymic tracheostenosis is immediate tracheotomy and the insertion of the cane-shaped cannula Fig. 215, which will insure safe breathing during thymopexy or subtotal thymectomy, which should be done at the same time as the tracheotomy. Operable goiter causing tracheal stenosis should be dealt with surgically. In cases of inoperable malignant goiter, the patient can be kept alive indefinitely so far as his tracheal stenosis is concerned by means of the cane-shaped tracheal cannula (Fig. 215) shown in place in the living patient in the radiograph (Fig. 229).

Stenoses of the Larynx.—*Acute stenosis of the larynx* has been referred to under Injuries and Foreign Bodies.

Congenital stenosis of the larynx has been noted in quite a number of cases of "blue baby."[1] The diagnosis can be quickly made with the direct laryngoscope.

Chronic stenoses of the larynx come to the surgeon for the abandonment of an intubation tube or a tracheotomic cannula which has been inserted in the more or less acute stage of the disease. Decannulation or extubation is prevented by various conditions which may be classified into the following types: (1) panic; (2) spasmodic; (3) paralytic; (4) ankylotic (arytenoid); (5) neoplastic; (6) hyperplastic; (7) cicatricial; (8) lost cartilage. In the panic type, which is seen only in children, the child has become so accustomed to breathing through the neck, which with a properly placed tracheotomic cannula is so much easier than breathing through the mouth, that the patient becomes frightened and feels that he is about to asphyxiate as soon as air is shut off from the cannula. In these cases a cork should be placed in the cannula after having a groove cut in the side of the cork which will permit air to pass. Subsequently other corks with a slit or groove of less size can be substituted, until the patient is weaned away. The spasmodic cases are amenable to the same method.

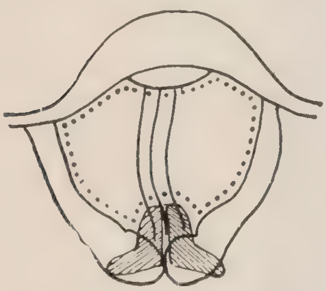


FIG. 230.—Direct laryngoscopic evisceration of the larynx for stenosis. All the tissues inside the dotted line are removed with punch-forceps under endoscopic guidance of the eye. (*Jackson.*)

Paralytic Stenosis.—Bilateral laryngeal paralysis causes a very severe stenosis. The best method of treatment is by complete evisceration of the interior of the larynx with the punch forceps used through the direct laryngoscope. The author has had a number of very successful results by this method (Fig. 230). After this operation the patient recovers a loud useful voice, though, of course, it will not be as good as if he had mobile arytenoids. In paralyses due to a small lesion in the neck, excision of the lesion and suture of the divided ends of the recurrent laryngeal nerve offer some hope. It was successfully done by J. Shelton Horsley and Clifton M. Miller.[2] Doubtless the sooner after the onset of the paralysis the suture is done the better, because of the tendency to degeneration of nerves and muscles from disuse.

Ankylotic stenoses of the larynx are amenable to endoscopic evisceration through the direct laryngoscope (Fig. 230).

Hyperplastic stenoses are curable by the endoscopic removal of the

[1] Chevalier Jackson. Peroral Endoscopy and Laryngeal Surgery. Text Book, 1914.

[2] Suture of the Recurrent Laryngeal Nerve. Trans. Southern Surg. and Gyn. Assn., Dec., 1909.

EXPLANATION TO PLATE I

1. Indirect view. Sitting position. Male, aged fourteen years. Post-diphtheritic stenosis cured by endoscopic evisceration. (See Fig. 5.) Known to be well two years after decannulation.

2. Indirect view. Sitting position. Male, aged 18 years. Patient very cyanotic because cannula was removed for laryngoscopy and bronchoscopy. Cured by laryngostomy. (See Fig. 6.) Still well four years after decannulation and plastic closure.

3. Indirect view. Sitting position. Male, aged 27 years. Post-typhoid infiltrative stenosis. Left arytenoid destroyed by necrosis. Cured by laryngostomy. Failure to form adventitious band (Fig. 7) because of lack of arytenoid activity.

4. Indirect view. Recumbent position. Male, aged 40 years. Post-typhoid cicatricial stenosis. Cured of stenosis by endoscopic evisceration with sliding punch forceps. Anterior commissure twice afterward cleared of cicatricial tissue as in other case shown in Fig. 15. Ultimate result shown in Fig. 8.

5. Same patient as Fig. 1. Sketch made two years after decannulation and plastic.

6. Same patient as Fig. 2. Sketch made four years after decannulation and plastic.

7. Same patient as Fig. 3. Sketch made three years after decannulation and plastic.

8. Same patient as Fig. 4. Sketch made one year after decannulation, 14 months after operative clearing of the anterior commissure to form adventitious cords.

9. Direct view. Recumbent. Female, aged 16 years. Web post-diphtheritic (?) or congenital (?) Patient had a "rough voice" since birth but larynx never examined until stenosed after diphtheria. Web removed and larynx eviscerated with punch forceps. Recurrence of stenosis (not of web). Cure by laryngostomy.

10. Direct laryngoscopic view. Child, aged 22 months. Post-diphtheritic hypertrophic subglottic stenosis. Cured by galvano-cauterization.

11. Direct laryngoscopic view. Child, aged 3 years. Post-diphtheritic hypertrophic supraglottic stenosis. Forceps excision. Extubation one month later. Still well four years later.

12. Bronchoscopic view of post-tracheotomic stenosis following a "plastic flap" tracheotomy done for acute œdema. Male aged 47 years. (Not treated because of advanced nephritis.)

13. Direct laryngoscopic view. Anterolateral thymic compression stenosis in a child of 18 months. Cured by thymopexy. Seen six months later. Still well.

14. Indirect (mirror) view. Laryngostomy rubber tube in position in treatment of post-typhoid stenosis. Woman, aged 30 years.

15. Direct view. Post-typhoid stenosis after cure by laryngostomy. Male, aged 30 years. Dotted line shows place of excision for clearing out the anterior commissure to restore the voice.

16. Endoscopic view of post-tracheotomic tracheal stenosis from badly placed incision and chondrial necrosis, in a child of three years. Tracheotomy originally done for influenzal tracheitis. Cured by tracheostomy.

PLATE I.

Laryngeal and tracheal stenoses. (*Reproductions of Chevalier Jackson's oil paintings from life.*)

hyperplastic tissue if the latter is located above the glottis. Below the glottis the galvanocautery, applied through the laryngoscope (Fig. 198), after the author's method, is uniformly successful.

Acromegaly.—Overgrowth of the laryngeal cartilages and endolaryngeal tissues, asymmetrical in character has been observed by the author.[1] Treatment is of no avail but tracheotomy is required early not only for the stenosis due to overgrowth but for the added element of spasm which may be present.

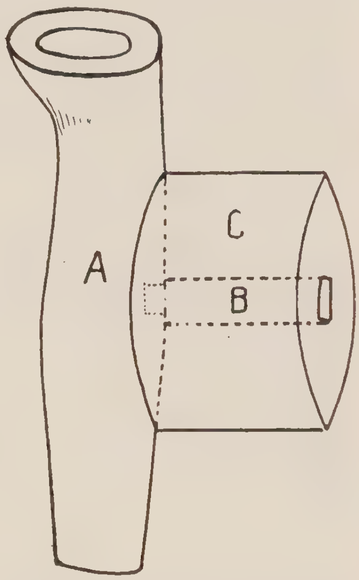


FIG. 231.—The author's self-retaining intubation tube for the treatment of chronic laryngeal stenosis. The tube (*A*) is introduced through the mouth, then the post (*B*) is screwed in through the tracheal wound. Then the block (*B*) is slid into the wound the square hole in the block guarding the post against all possibility of unscrewing. If the threads of the post are properly fitted and tightly screwed up with a hemostat, however, there is no chance of unscrewing, and gauze packing is used instead of the block to maintain a large fistula. The shape of the intubation tube has been arrived at after long clinical study and trials, and cannot be altered without risk of falling into errors that have been made and eliminated in the development of this shape. (*Jackson.*)

Cicatricial stenoses may follow tuberculosis, lues, perichondritis, diphtheria, typhoid fever or trauma. In many cases the cicatrices are enabled to obliterate the lumen of the larynx entirely because of more or less loss of the cartilaginous framework which normally should keep the laryngeal lumen open. Plastic operations with transplantation of cartilage have not as yet been successful. If there is not excessive loss of cartilage, however, practically every case of cicatricial stenosis can be cured, the tracheal fistula closed and normal breathing through the mouth restored. The treatment, however, is long and tedious, requiring untiring patience and careful watching to be successful.

Three methods of treatment have been used. The first that should be tried is incomplete endoscopic evisceration through the direct laryngoscope. If there is arytenoid mobility great care should be taken not to injure the arytenoids, nor to remove too much of the interior muscles, because the pull of the arytenoids will afterward assist greatly in forming an adventitious cord from the cicatricial tissue, as demonstrated by the author.[1] If endoscopic evisceration fails, prolonged intubation may be tried. Increasing sizes of intubation tubes, modeled to suit the

[1] Chevalier Jackson. Peroral Endoscopy and Laryngeal Surgery. Text Book, 1914.
[1] Chevalier Jackson. Peroral Endoscopy and Laryngeal Surgery, 1914.

case, are used. The ordinary intubation tube sold for use in diphtheria is of no value for this purpose. For adults increasing adult sizes must be used. Excellent results have been obtained by the author with the tube shown in Fig. 231. With this in place the patient is perfectly safe, so far as the coughing out of the tube is concerned, because of the post. From three months to a year is required for cure. Should this fail, laryngostomy must be resorted to.

Laryngostomy.—Laryngostomy is the name given to the operation of splitting the larynx anteriorly and keeping it open for a long period of treatment during which the interior of the larynx becomes epidermatized with epidermal epithelium. The obstructing cicatrices are softened and caused to disappear by the elastic pressure of soft rubber tubes inserted in the laryngeal lumen. With a sufficient degree of patience on the part of both patient and surgeon, a cure can be obtained

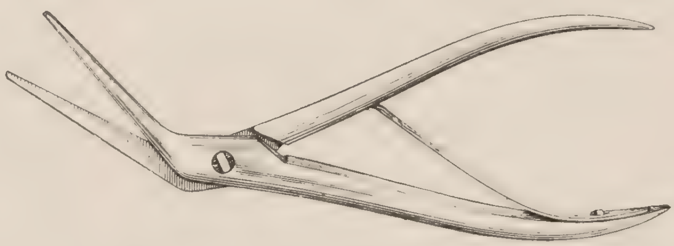


FIG. 232.—Author's tubinotome, originally designed for turbinotomy and afterward found ideal for splitting the thyroid cartilage in thyrotomy (laryngofissure) and laryngostomy. (*Jackson.*)

in the most stubborn cases, provided there has not been too great a loss of the laryngeal cartilaginous framework. From six months to a year or more may be required.

The technique of the operation is simple. The turbinotome (Fig. 232) is inserted through the tracheotomic wound, as shown in Fig. 222, the point projecting upward. The anterior laryngeal wall is thus divided at one clip in the median line which has been locally infiltrated with a solution of one-tenth of 1 per cent. of cocaine, the injection being intradermatic, not hypodermatic. The larynx is spread with retractors. If there are web-like bands running across the larynx they are excised. Thick masses of infiltration may also be extirpated. If the posterior laryngeal wall is much infiltrated, a vertical linear incision is then made on the anterior surface of the back wall of the larynx, exercising great care not to go through to the œsophagus. The skin is stitched to the deeper tissues though preferably not to either the cartilage or the perichondrium. This will cause a dipping down of the skin surface so as to start the epithelialization of the interior of the larynx with epidermal

epithelium. The apparatus (Fig. 233, using the laryngostomy cannula, Fig. 234), is then inserted and the wound dressed by inserting a large piece of gauze over the front of the neck. At the site of the wound a roll of gauze is forced down to cause the wound to gape. Bits or strings of gauze are not used lest they get into the trachea.

After-care.—Success depends altogether on the after-care and unless the surgeon is prepared to devote daily attention for many months,

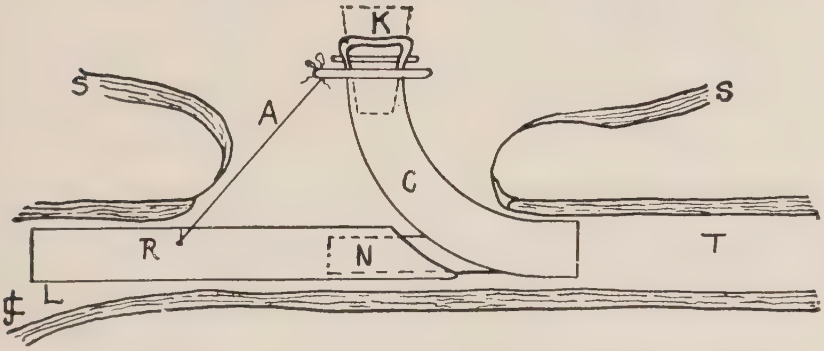


FIG. 233.

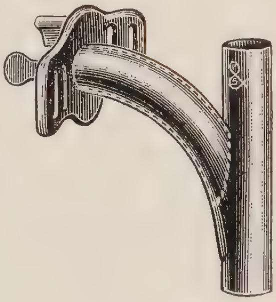


FIG. 234.

FIG. 233.—Schema showing the author's method of laryngostomy. The hollow upward metallic branch (*N*) of the cannula (*C*) (see also Fig. 234) holds the rubber tube (*R*) back firmly against the spur (*E*) on the backwall of the trachea. Moreover, the air passing up through the rubber tube (*R*) permits the patient to talk in a loud whisper, the external orifice of the cannula being occluded most of the time with the cork (*K*). (*Jackson.*)

FIG. 234.—The author's laryngostomy cannula. A short piece of rubber tubing in increasing sizes, and of proper length, is placed over the upper branch. (*Jackson.*)

laryngostomy should not be undertaken. The apparatus is removed at first every day and afterward every alternate day. About once each week the size of the rubber tubing is increased until it has reached the size of No. 40 French for an adult. The metallic part of the apparatus is maintained the same, without increase. In children the limit of size of the rubber tubing will be reached according to age. When the maximum size has been reached, it is continued throughout the period of treatment. The vertical extent of the external wound must not be allowed to diminish but must be kept as an open trough. Applications of scarlet red in 10 per cent. ointment will favor epithelialization. When a sufficient lumen has been reached and maintained for three or four months completely epithelialized, the apparatus may be abandoned, and a dressing placed over the wound lightly without pressure. When the patient has been able to sleep quietly at night for six months with the neck wound covered, the case may be pronounced well and the plastic operation, Fig. 235, may be done to close the fistula.

Closing of Tracheal Fistulæ.—Any time within a few weeks after tracheotomy the wound will close promptly when the cannula is aban-

doned; but tracheal fistulæ resulting from prolonged wearing of a cannula become lined with epidermal epithelium and often refuse to heal. They can be readily closed by the plastic operation shown in the schema (Fig. 235). This method is applicable also to closure of the laryngostomic opening after cure of laryngeal stenosis.

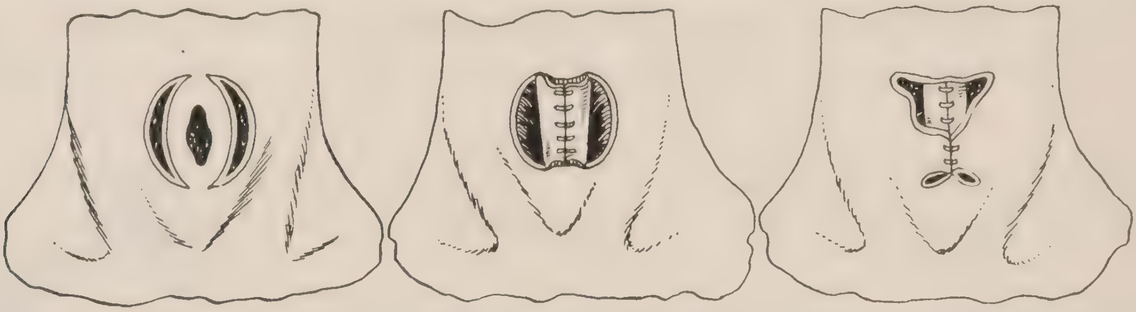


FIG. 235.—Plastic operation for the closure of a tracheal fistula. The flaps are turned epidermal surface inward. The raw surface of the flaps is then covered by drawing the skin together thereover with a second series of sutures. The turning in of hair-bearing epidermis must be avoided. (*Jackson.*)

TRACHEOTOMY

Indications.—Tracheotomy is indicated as a therapeutic measure in certain diseases of the larynx such as tuberculosis, lues, and papillomata. Perichondritis and necrosis of the larynx and trachea are much benefited by tracheotomy. The chief indication for the operation is, however, stenosis of the larynx from any cause whatever. In the absence of stenosis it may be indicated for respiratory arrest, for the insufflation of oxygen or other means of artificial respiration. Formerly it was used for the removal of foreign bodies from the larynx and trachea, but since the development of direct laryngoscopy and bronchoscopy it is regarded as justifiable to do a tracheotomy in foreign body cases only when needed for dyspnœa.

Mortality.—The mortality of tracheotomy is less than one-half of 1 per cent. if considered apart from the conditions calling for it. Formerly it was blamed for many deaths which were due to lack of promptness in performing it. It should always be done early rather than late. Of 472 tracheotomies done in their clinic and elsewhere by Dr. Patterson and the author, there was a mortality of six (1.27 per cent.). This includes all cases that died from any cause whatever within a week of the operation.

Anæsthesia should be local. General anæsthesia not only is unnecessary but introduces an enormous element of risk out of all proportion to the anæsthetic risk in the general run of surgical work. The dangers of general anæsthesia may be primary from asphyxia or secondary from aspiration of infected blood, pus or secretions owing to the

abolition of the cough reflex. All that is necessary is to infiltrate the skin by the intradermatic (not hypodermatic) injection of salt solution to which one-tenth of 1 per cent. of cocaine has been added.

Technique.—For tracheotomy the essentials are a knife and a pair of hands. Even eyesight is not absolutely essential, and the author twice has been quite successful in a dark room with nothing but a knife. Such performances, while life-saving and justifiable in emergencies, are to be avoided by early operation with proper preparation. Besides general operating instruments a tracheal cannula should be provided and a good headlight is of great service. The tracheotomic cannulæ of the shops are all defective because they are too short. When the reactionary swelling has set in, the cannula is withdrawn from the interior of the trachea though, unfortunately, a thin stream of air still passes and the fact that the inner end of the cannula is not in the trachea is overlooked. The author has devised a proper set of cannulæ each one with its own pilot (Fig. 236).

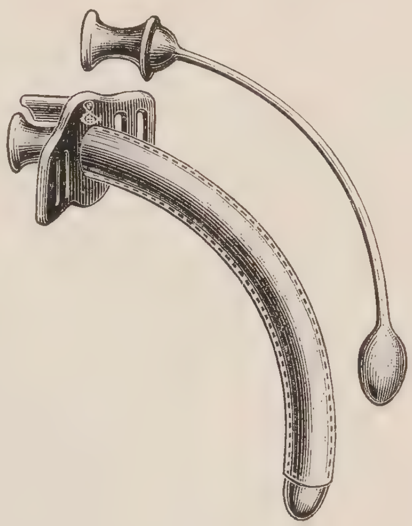


FIG. 236.—Authors' tracheotomic cannula and pilot, for ordinary cases. The defects of the cannulæ of the shops are eliminated. For deep tracheal stenoses the cane-shaped cannula Fig. 215 is used. Both forms are made in six sizes.

The classical description of the division of tissues after identification layer by layer on a grooved director is a needless, time-wasting encumbrance. The skin and subcutaneous cellular tissues should be cut at the first stroke of the knife. This incision should be exactly in the median line and should extend from the thyroid notch to the suprasternal notch. The subcutaneous tissues are then divided by shallow incisions the vessels being drawn aside with retractors held by an assistant, or seized before division, as may seem best. The back of the point of the knife may be used as a blunt dissector if desired. The trachea should be laid bare at the cricoid first and then followed downward. When the entire trachea from the cricoid to about the fifth ring has been bared, the thyroid isthmus being retracted either upward or downward as seems easiest, and all bleeding having been arrested, the trachea may be incised at the desired location, including at least three tracheal rings in the incision and taking care not to incise the posterior tracheal wall. It has been customary to describe two operations, the high and the low tracheotomy. This is a great misfortune. The trachea should be laid

bare first and then the site of incision determined upon; and, unless for some very special reason, the incision should never be higher than the second ring of the trachea. High tracheotomies have caused many cases of laryngeal stenosis by approaching too closely to the subglottic tissue which is very prone to chronic hyperplasia.

The wound in the trachea is spread with a Trousseau dilator or with

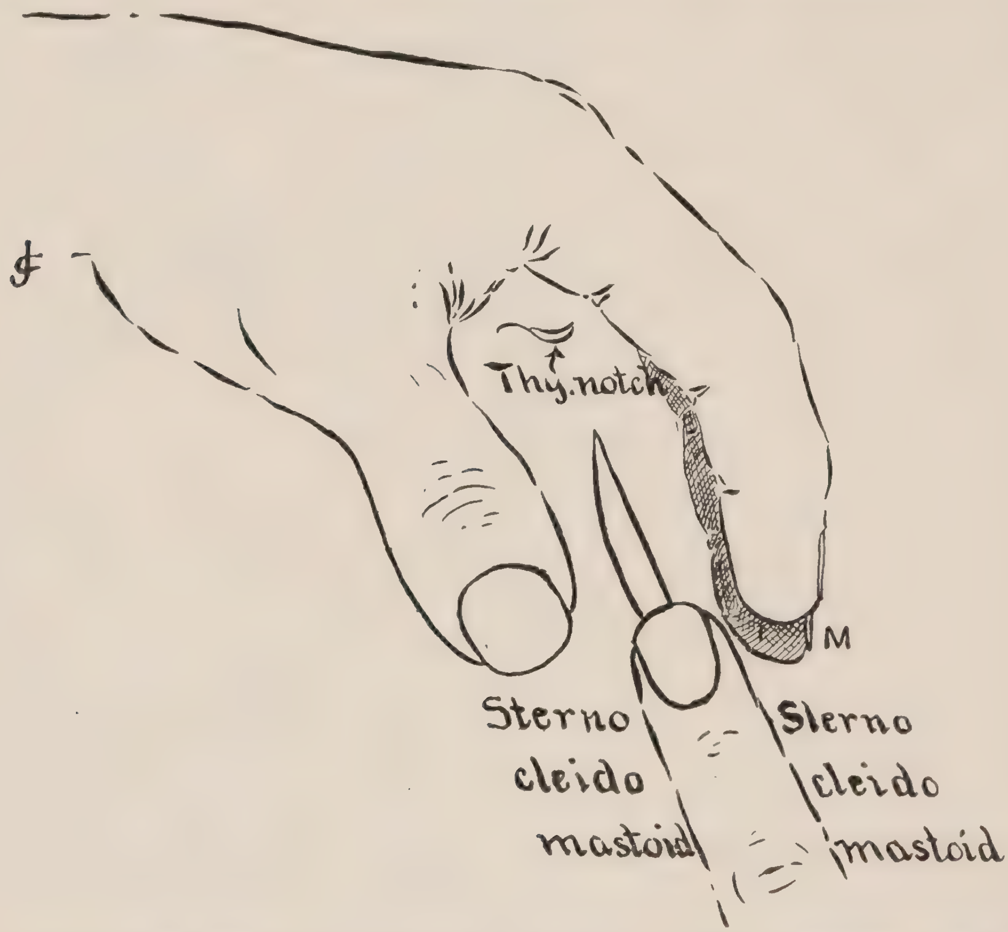


FIG. 237.—Schema showing the author's method of rapid, emergency tracheotomy. First stage. The hands are drawn ungloved for the sake of clearness. The upper hand is the left, of which the index-finger and the thumb are used to repress the sternocleidomastoid muscles, the finger and thumb being close to the trachea in order to press backward out of the way the carotid arteries and the jugular veins. This throws the trachea forward into prominence and one deep slashing cut will incise all of the soft tissues down to the trachea. (*Jackson.*)

a hemostat, and the tracheotomic cannula is inserted. A stitch or two may be placed at the upper and lower angles of the skin wound but under no circumstances should the whole wound be stitched up tightly close to the tracheotomic cannula. The wound around the cannula should be packed with gauze, using the center of a large piece for the purpose so that no end can get down into the trachea. A filter piece of gauze is then placed over the tracheal cannula, both pieces of gauze being attached to the tape with a safety pin.

It must always be remembered that if the dyspnœa is not completely relieved upon the insertion of the cannula, that something is

wrong. It may be occlusion of the cannula with exudates or secretions; but usually it is because the stenosis is in the lower trachea. It is astonishing how many cases have died unrelieved by tracheotomy simply because a cane-shaped cannula, such as that shown in Fig. 215, was not used, the stenosis being beyond the reach of the ordinary cannula.

Emergency Technique.—The stabbing of the cricothyroid membrane or the attempt at stabbing of the trachea so long advocated as an

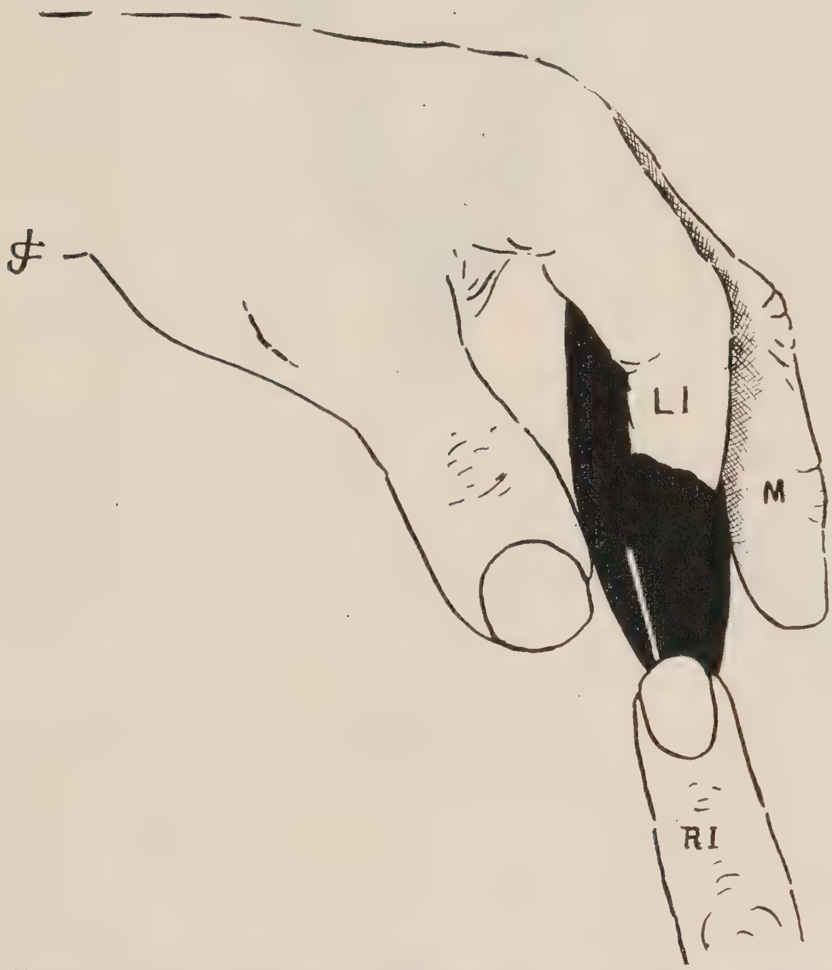


FIG. 238.—Illustrating the author's method of emergency tracheotomy. Second stage. The fingers are drawn ungloved for the sake of clearness. In operating the whole wound is full of blood and the rings of the trachea are felt with the left index-finger, which is then moved slightly to the operator's left, while the knife is slipped down along the left index finger to exactly the middle line when the trachea is incised. (*Jackson.*)

emergency tracheotomy has led to many cases of stenosis and even worse disasters. A better, more certain and equally quick method is the author's "two stage, finger guided" method as shown in Figs. 237 and 238. As shown in Fig. 239, the detailed anatomy is ignored, and schematic gross anatomy memorized. The first incision divides the skin, thyroid isthmus and all tissues down to the trachea, the rings of which are divided at the second incision guided by the sense of touch in the tip of the left forefinger. The trachea cannot be seen because of the free hemorrhage.

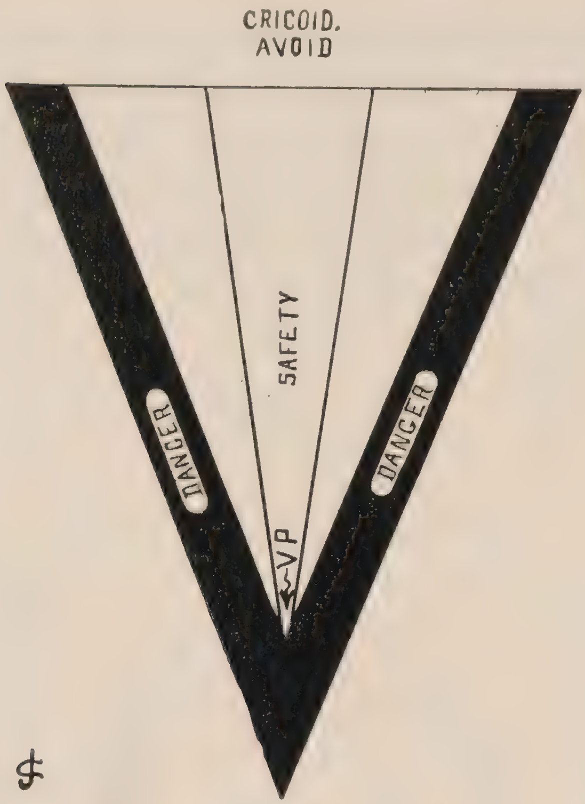


FIG. 239.—Schema of practical gross anatomy to be memorized for emergency tracheotomy. The middle line is the safety line, the higher the wider. Below, the safety line narrows to the vanishing point *VP*. The upper limit of the safety line is the thyroid notch until the trachea is bared, when the limit falls below the first tracheal ring. In practice the two dark danger lines are pushed back with the left thumb and middle finger as shown in Fig. 237, thus throwing the safety line into prominence. The tracheal incision should be vertical and exactly in the middle line of the trachea. (*Jackson.*)

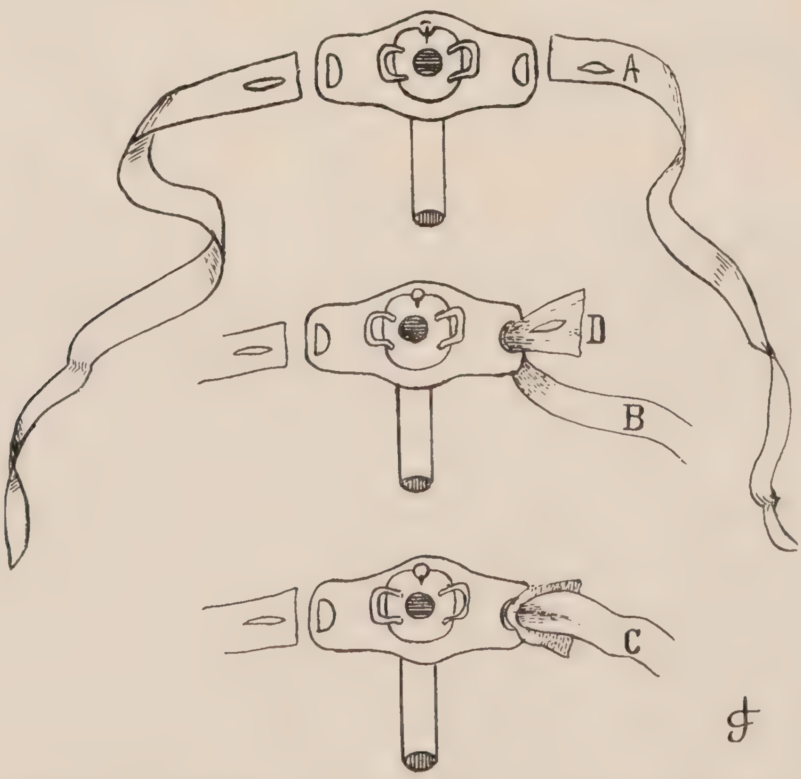


FIG. 240.—Schematic illustration of Dr. Ellen J. Patterson's method of attaching the tapes to tracheotomic cannulæ. Near the end, *A*, a slit is cut in the tape with scissors. The end, *A*, is then passed through the slot in the tape plate from the under side as shown at *D*. The end, *B*, is then pulled through the slit in the tape and drawn taut as shown at *C*. The tape must be not less than 16 mm. (5/8 in.) wide and be good, strong linen. (*Jackson.*)

After-care of Tracheotomized Patients.—Dressings should be wrung out of mercuric bichloride solution 1:10,000, and should be changed every third hour with the exception of the filter piece which should be changed as often as it is soiled, probably every few minutes, at times. A nurse trained in tracheal work should be on hand to sponge away secretions when they are coughed up. This must be done quickly before the secretions are aspirated back into the tube. Under no circumstànces should any antibechic, such as the opium derivatives, be given because the cough reflex is the watchdog of the lungs, and if uninterfered with there will be no danger of aspiration pneumonia. Routine hospital post-operative care has resulted in an enormous post-operative mortality from accidents to the tube, with no help present other than nurses and internes inexperienced in tracheotomic work.

ŒSOPHAGOSCOPY AND GASTROSCOPY

Œsophagoscopy and gastroscopy are procedures using tubes which serve as specula for the examination of the interior of the œsophagus and the stomach.

Instruments.—All practical œsophagoscopes and gastroscopes are straight and rigid tubes. Some effort has been made from time to time to develop angular œsophagoscopes (the best one is that of Lewisohn), but their necessity is not apparent because a straight and rigid tube, introduced by sight, can be passed in less than one minute of time through the œsophagus into the stomach of any human being whose mouth can be opened. To do this safely and quickly, however, requires practice. The tubes most used at present are Brünings, (Fig. 197), Kahler's (Fig. 196) and Chevalier Jackson's (Fig. 198). Good results have been obtained with all of these instruments for work in the œsophagus, but only the last is available for use in the stomach because the light from the two first-mentioned is inadequate to reach through a sufficiently long tube. An œsophagoscope with ballooning attachment has been devised by Mosher.[1] Various accessory instruments needed are shown in Fig. 198 and are hereinafter mentioned.

Indications.—Any symptom of discomfort or difficulty in swallowing calls for an immediate œsophagoscopy. Any case of suspected foreign body in the œsophagus is an urgent indication for œsophagoscopy, and no external operation on the œsophagus is ever justifiable, for foreign body or disease, without a previous œsophagoscopy. While radiography has taught us much about the œsophagus, œsophagoscopy

[1] Loeb's Operative Surgery of the Nose, Throat and Ear.

is indicated in every case of œsophageal disease before operation. Œsophagoscopy and radiography together have led to an accuracy of diagnosis which has put the surgery of the œsophagus on an entirely new basis.

Contraindications.—The only contraindications to œsophagoscopy are aneurism and a serious state of disease of the cerebral blood-vessels. Even these are not a contraindication in case of foreign body in the œsophagus. If the patient is admitted in a serious state of water starvation, œsophagoscopy or any other procedure is contraindicated until water has been introduced into the system either through the bowels or, if necessary, by means of a gastrostomic opening. Diagnosis should in all cases wait until the very dangerous condition of water starvation has been ameliorated.

Anæsthesia.—No anæsthetic, general or local, is needed for the passing of an œsophagoscope in either adults or children, either for diagnosis or for the removal of foreign bodies. The only exception to this is in case of foreign bodies of very large size with one or more rough points which might seriously injure the œsophageal wall if withdrawn through a tightly spasmodically contracted œsophagus. If the foreign body is large in one diameter only, no matter how sharp and pointed, the mechanical problem of its removal can be solved without anæsthesia. The personal equation of the operator, however, must be considered, and it is perfectly justifiable to use an anæsthetic if the operator feels that he can do better work. Unquestionably the œsophagoscope is more easily introduced with an anæsthetic than without; but it is equally true that anæsthesia introduces a risk in the œsophagoscopy that is out of all proportion to the anæsthetic risk in any other class of cases, because of the interference with respiration likely to follow the displacement of a foreign body overridden by the œsophagoscope, which results in a compression stenosis of the trachea.

Preparation of the Patient.—The teeth should be brushed and the mouth cleansed by rinsing with peroxide of hydrogen followed by a gargle of 25 per cent. alcohol. In all œsophageal cases that are stenotic, the œsophagus should be emptied of food and secretions by regurgitation, which is usually easily done voluntarily by the patient subject to chronic stenosis.

Position of the Patient.—The easiest method of introduction of the œsophagoscope is by the author's "high-low" method. For this the head of the patient must be beyond the end of the table but, as shown by Boyce, it must not hang in the Rose position. On the contrary,

it must be elevated and moderate extension should be made at the occipito-atloid joint. The shoulders should be about 2 in. beyond the head-end of the table, the head being out in the air supported by the second assistant as shown in Fig. 241. The second assistant makes extension of the head with his left hand, and to prevent fatigue the left elbow is rested on the left knee, the left foot being elevated on a stool, the top of which is 26 in. lower than the top of the table. The second assistant's left arm passes under the patient's neck so that the index-

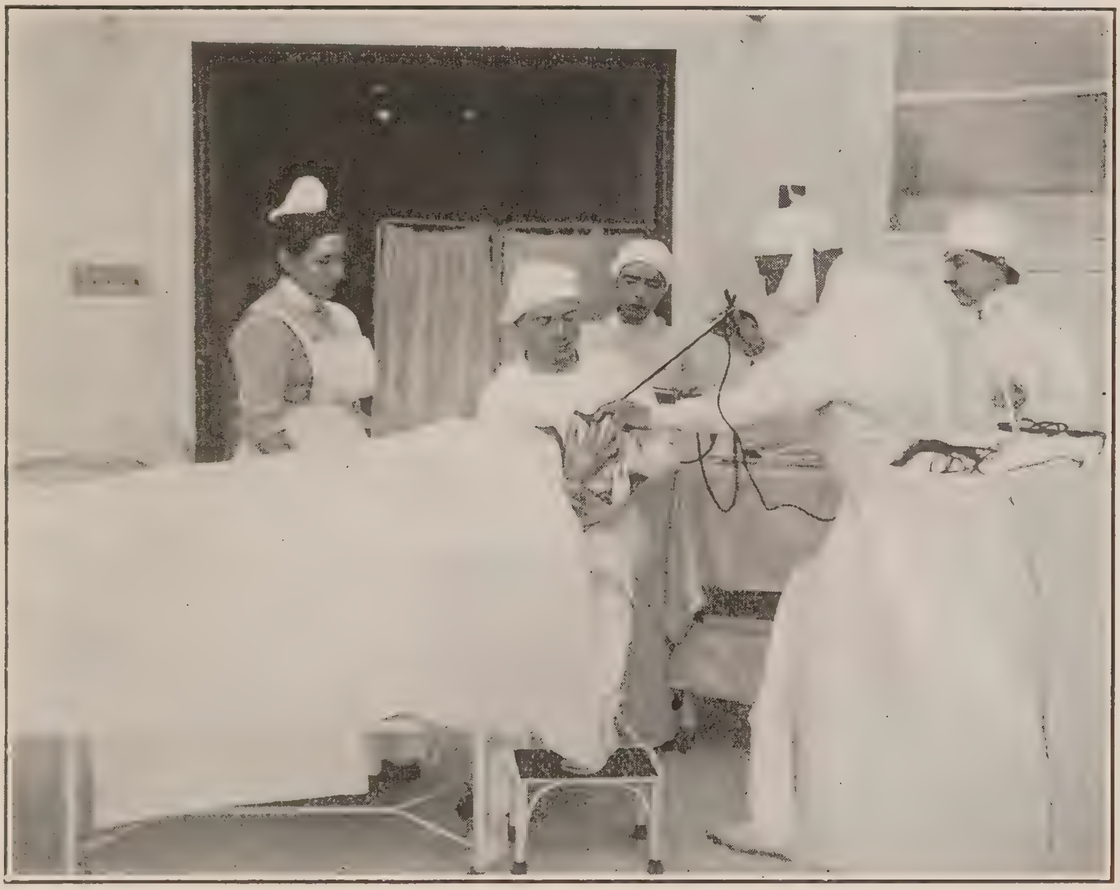


FIG. 241.—Chevalier Jackson's "high-low" method for œsophagoscopy. First stage. The patient's head is high, the vertex being about 15 cm. above the table-top (adult patient) during the introduction of the œsophagoscopic tube-mouth into the right pyriform sinus. It is but very slightly, if at all, lowered during the passage through the cervical œsophagus (second stage), or through the upper thoracic œsophagus (third stage).

finger can be used to hold in place the bite-block (*G*, Fig. 198). Wide gagging must not be used. The sitting position is sometimes used for œsophagoscopy, but it has the great disadvantage that secretions flow down and obscure the field and are much more difficult to remove against gravity. In case of children, the patient is very much more easily controlled in the recumbent position. One nurse holds the two wrists of the child down on the table while another nurse holds down the knees. This, with an experienced head-holder, gives absolute control of the patient. As shown by the author, it is necessary to remember

that the upper third of the œsophagus goes backward as well as downward. Therefore if the head be drawn backward as if the neck were to be shaved, an anteriorly convex curve is put in the cervical œsophagus. These points are the foundation of the author's "high-low" position for œsophagoscopy, which has made œsophagoscopy easy for the operator and the patient.

Introduction of the Œsophagoscope.—The œsophagoscope is introduced through the right pyriform sinus, the position of which, in the

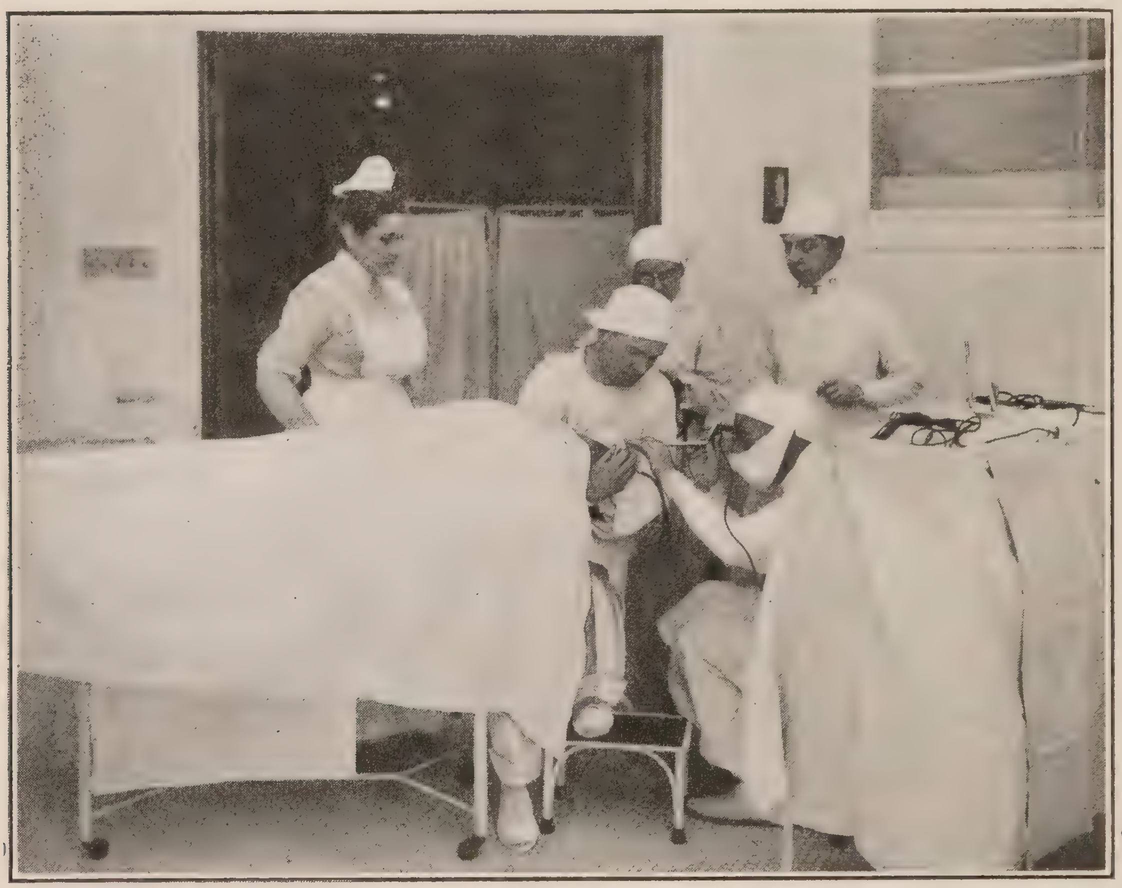


Fig. 242.—Chevalier Jackson's "high-low" method of œsophagoscopy. Fourth stage. The patient's head is lowered until the vertex is about 5 cm. (adult patient) below the table-top during the passage of the tube-mouth through the hiatus, the abdominal œsophagus and the cardia.

recumbent patient, is shown in the schema, Fig. 243. To understand the schema it is necessary to remember that the cricoid cartilage lies tightly against the cervical spine and there is no room to pass a tube between these two structures. At the side, however, the pyriform sinuses, through which food normally passes, are elastic though collapsed channels, through which the œsophagoscope is readily introduced until stopped by the contraction of the cricopharyngeus which obstructs the tube-end like a wall. When this obstacle is encountered it is necessary to elevate the distal end of the œsophagoscope in an anterior direction, the lip of the tube-mouth being upward. In a few

moments spasm of the cricopharyngeus will relax and the tube will enter readily into the cervical œsophagus, which is seen to open on inspiration and to close on expiration. Passing downward, the whole œsophagoscope pointing in a backward direction as if aiming for the lumbar region, the thoracic œsophagus is seen not to entirely close during expiration while the negative pressure in the thorax causes it to gape widely on inspiration. A narrowing is noticed at the crossing of the left bronchus, after which it will be noticed that the lumen of the œsophagus begins to turn anteriorly. At this point the head must be dropped and the œsophagoscope must be pointed anteriorly (upward in the recumbent patient) as if aiming for the anterior superior spine of the ilium (Fig. 242). This direction of the tube is necessary to pass the hiatus œsophagus and the abdominal œsophagus. The hiatus is

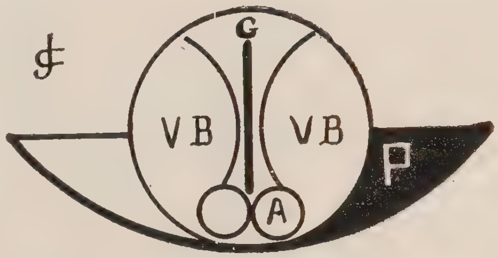


FIG. 243.—Scheme for finding the right pyriform sinus in the author's "high-low" method of œsophagoscopy. The circle represents the cricoid cartilage. VB, ventricular bands. A, right arytenoid eminence, over which the tube-mouth must not be "hooked." P, right pyriform sinus through which the œsophagoscope must be passed. (*Jackson.*)

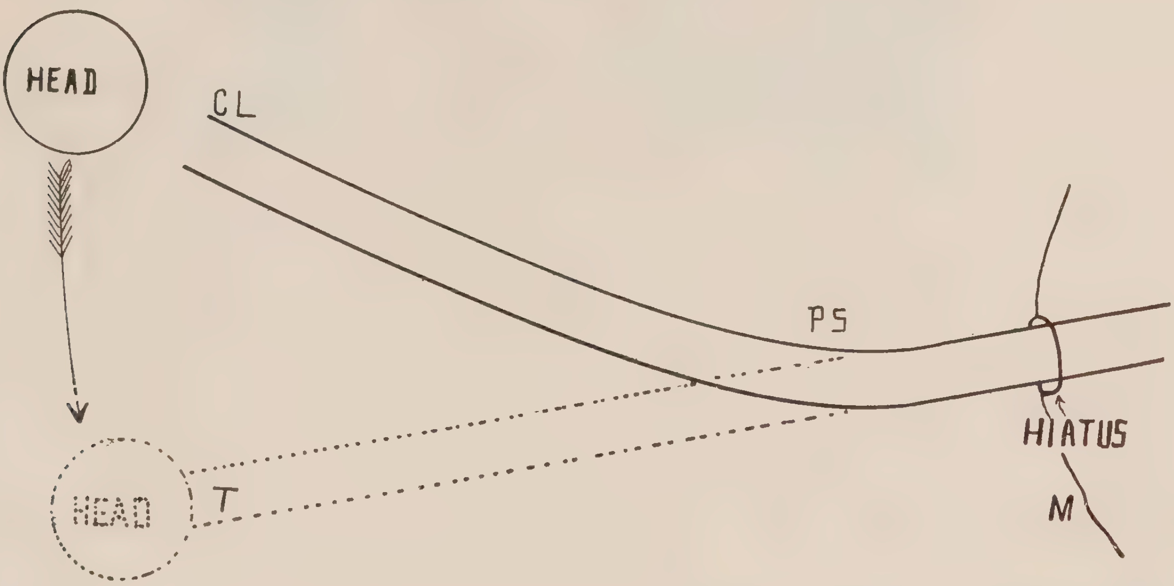


FIG. 244.—Schematic illustration of the author's "high-low" method of œsophagoscopy. Fourth stage. To pass the hiatus the head is dropped from the position CL (which it has occupied during the first, second and third stages) to the position shown by the dotted line, T, the head and shoulders at the same time being moved (without rotation) to the patient's right. (*Jackson.*)

noted to be tightly contracted in a puckered rosette, sometimes more or less slit like. Gentle pressure and a few moments waiting, the tube being properly centered over the hiatus, will result in relaxation of the spasmodic contraction and the œsophagoscope will slip readily through

the hiatus and abdominal œsophagus into the stomach. This "high-low" method of œsophagoscopy makes œsophagoscopy very easy, after experience is acquired. The proper position of instruments and patient, as here given, easily brings the axis of the alimentary canal straight, from the right corner of the mouth to the greater curvature of the stomach (Fig. 244).

During introduction the aspirating attachment to the œsophagoscope keeps the field free from fluid. Particles of food and very thick secretions may need to be wiped away with the sponge carrier armed with gauze sponges.

Œsophagoscopy for Foreign Bodies.—The œsophagoscopic removal of foreign bodies has reached such a high state of perfection that it may be stated that with an operator of experience, any foreign body that has gone down through the mouth may be removed the same way, and that the blind use of probangs, forceps and bougies and also the operation of external œsophagotomy are all unjustifiable for foreign bodies, unless an experienced œsophagoscopist is unavailable. It must be borne in mind, however, as pointed out by John C. DaCosta[1] that the œsophagoscope in the hands of the inexperienced may be more dangerous than external œsophagotomy.

Of 206 cases of œsophagoscopy for foreign bodies in the author's clinic,[2] the foreign body was removed in 198 and escaped downward in eight. In the 206 cases there was one death, a woman of 56 years of age with advanced nephritis. Three other deaths occurred in patients admitted with severe laceration of the œsophagus from violent attempts at removal by blind methods prior to admission.

Almost all foreign bodies lodge in the œsophagus at the level of the upper thoracic aperture (Fig. 245) because there is a physiological narrowing at this point. In this location the foreign body may be removed either by the œsophagoscope with long forceps or with the author's œsophageal speculum (Fig. 246) and the alligator forceps of Mosher.

In the case of smooth, round foreign bodies, such as coins, the intruder can be seized as soon as seen and removed. Not so, however, with sharp and rough foreign bodies. The mechanical problem of the removal must be studied so that the intruder can be brought out without trauma. The œsophagus, is, surgically, one of the most intolerant organs in the body. It requires only slight trauma to cause œsophagitis, sloughing, septic mediastinitis or mediastinal emphysema, all of

[1] John C. DaCosta. Modern Surgery. 7th Edition, 1914.

[2] Chevalier Jackson. Peroral Endoscopy and Laryngeal Surgery, 1914.

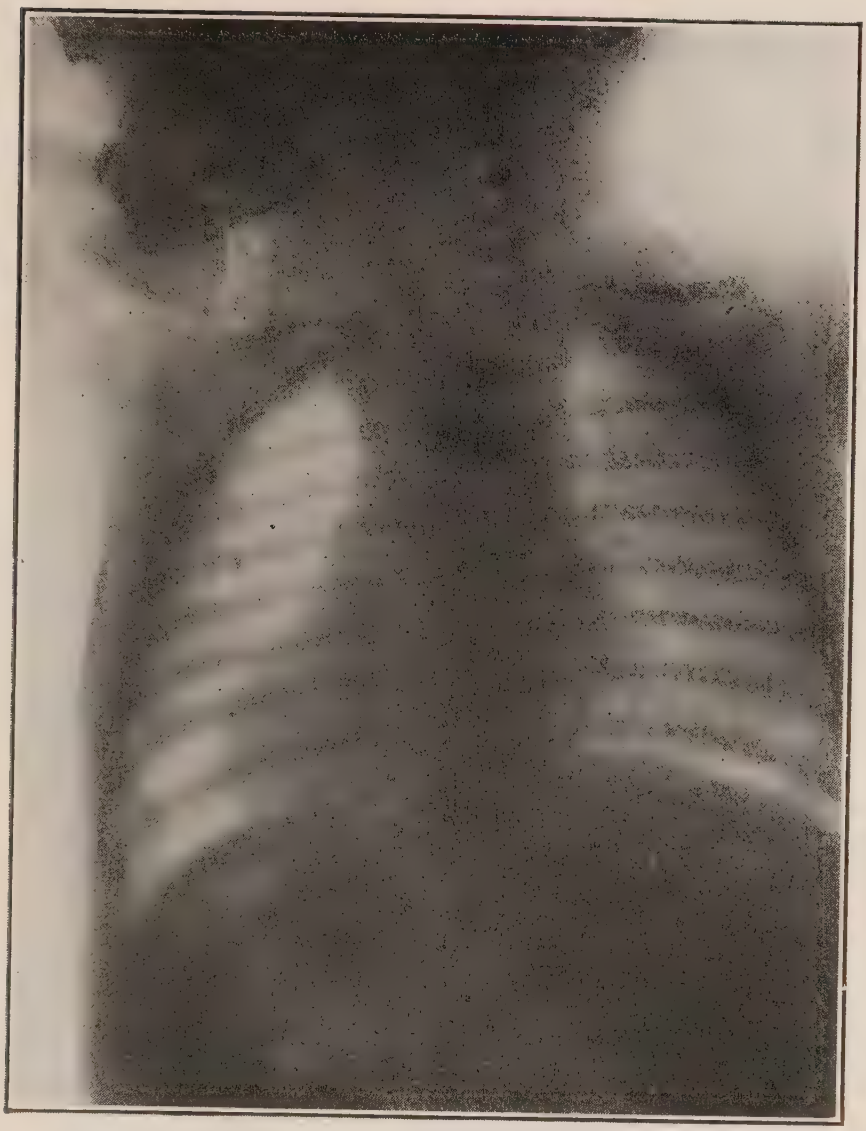


FIG. 245.—Radiograph of cuff-link in the œsophagus of a child 17 months old. Cuff-link removed by œsophagoscopy, bloodlessly, through the mouth, without anæsthesia, general or local. (*Author's case. Radiograph by Johnston and Grier.*)

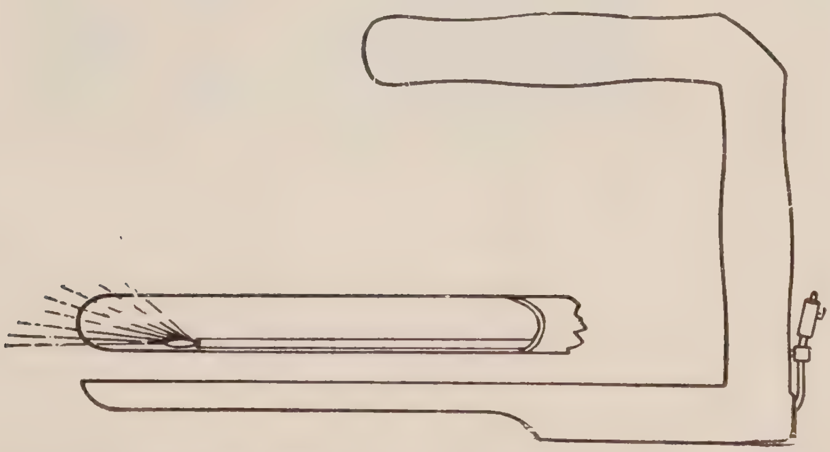


FIG. 246.—The author's œsophageal speculum, useful in the upper third of the œsophagus for the diagnosis and treatment of disease and for the removal of foreign bodies. Two sizes are needed, one for adults and one for children.

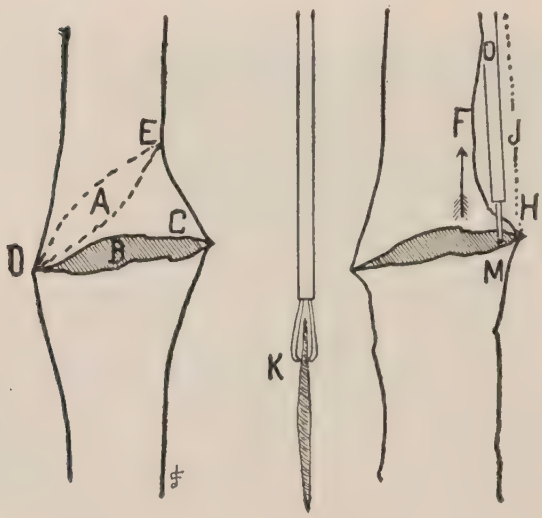


FIG. 247.—The problem of the horizontally transfixed, sharply pointed foreign body in the œsophagus. The point, *D*, has caught as the bone, *A*, was being swallowed. The end, *E*, was forced down to *C*, by food or by blind attempts at pushing the bone downward. The wall, *F*, should be pushed laterally out to *J*, permitting the forceps to grasp the end, *M*, of the bone, *B*. Traction in the direction of the dart will disimpact the bone and permit it to rotate so that one point comes into the tube-mouth, while the other point trails harmlessly behind during extraction. The author's rotation forceps that touch only at the points must be used to permit rotation as shown at *K*. (*Chevalier Jackson.*)

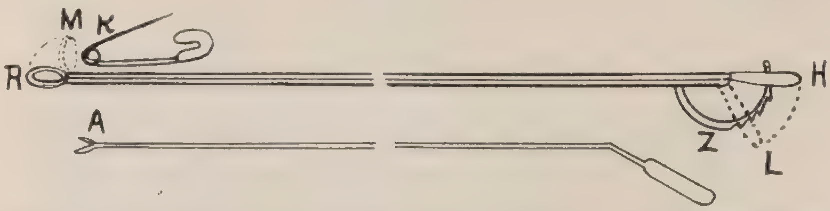


FIG. 248.—Schema illustrating the endoscopic closure of open safety pins lodged point upward. The closer is passed down under ocular control until the ring, *R*, is below the pin. The ring is then erected to the position shown dotted at *M*, by moving the handle, *H*, downward to *L* and locking it there with the latch, *Z*. The fork, *A*, is then inserted and engaging the pin at the spring loop, *K*, the pin is pushed into the ring, thus closing the pin, which is then safely removed with forceps. (*Jackson.*)

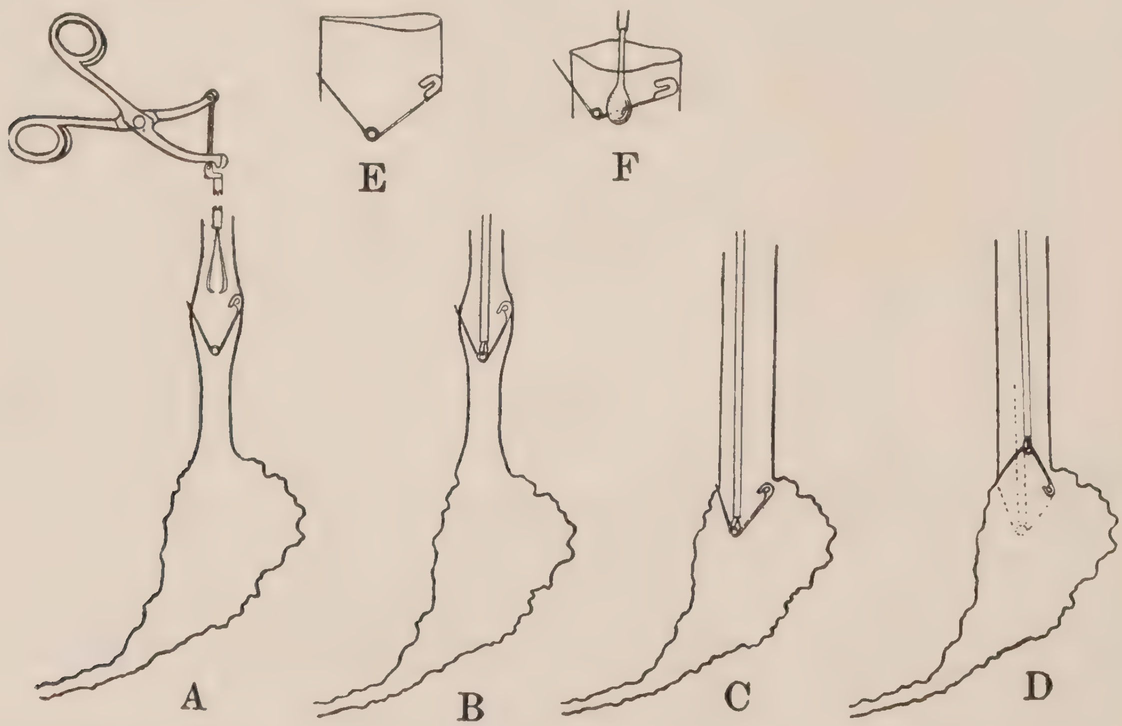


FIG. 249.—At *E*, *F*, is shown how the œsophageal wall would be perforated by attempted withdrawal of an open safety pin lodged point upward in the œsophagus. *A*, *B*, *C*, *D*, show successive stages of a safe method of removal by passing the pin into the stomach, turning and removing by special forceps which retain the pin securely, though permitting it to turn. The entire procedure is under œsophagoscopic guidance of the eye. (*Jackson.*)

which are almost invariably fatal. In case of transfixed bodies they should be seized by one end as shown in the schema (Fig. 247). In the case of foreign bodies such as safety pins, lodged point upward, violent removal would result in fatal trauma of the œsophagus. The pin can be closed before removal with the author's closer shown in Fig. 248, or it can be passed into the stomach, there turned, and removed as shown schematically in Fig. 249. In case of round disc-like

FIG. 250.—Lateral radiograph showing safety pin lodged point upward in the œsophagus of an infant, 11 months old. Removed by œsophagoscopy, bloodlessly through the mouth, without anæsthesia. (*Author's case. Radiographic plate made by Dr. George C. Johnston.*)

bodies having a sharp projection, as in a campaign button, it is necessary to seize the pin by the point, if the point is upward. Good forceps will give a sufficiently tight hold for this to be done. If necessary, the disc can be seized after the point is safely in the tube. If the point be out laterally, it is necessary to seize the disc at a point opposite the pin so as to permit rotation. For this purpose the author's rotation forceps that touch only at the points (*K*, Fig. 247) are needed.

The average time required for the œsophagoscopic removal of a foreign body is one or two minutes. Very complicated mechanical problems, such as in case of open safety pins, double-pointed tacks, and the like, may prolong the operation to 10 or 15 minutes. In the early days of œsophagoscopy the procedure was prolonged sometimes to an hour or two without subsequent reaction, if manipulations were gentle.

FIG. 251.—Steel dilator of Mosher in place fully expanded in the hiatal and abdominal œsophagus of a living patient, undergoing treatment for hiatal œsophagismus (so-called "cardiospasm.") (*Author's case.*)

The reader interested in the many mechanical problems of œsophagoscopic foreign-body extraction is referred to a special work on the subject.[1]

Fluoroscopic Removal of Foreign Bodies.—The fluoroscopic guidance of forceps passed through the mouth for the removal of foreign bodies has been successful in a few cases, and fatal in a number of other

[1] Chevalier Jackson. Peroral Endoscopy and Laryngeal Surgery, 1914.

cases. It is exceedingly dangerous as compared with œsophagoscopy under guidance of the eye looking through the œsophagoscope, and it is necessarily limited to those cases in which the foreign body is very dense to the ray. It is but little better than the now obsolete, often fatal, blind methods with probang, forceps and bougie.

GASTROSCOPY

Gastroscopy has given to the diagnosis of stomach diseases all the certainty of actual inspection. The interior of the left two-thirds of the stomach is open to gastroscopic exploration in every case. In some cases the pyloric end can also be inspected. Should a mass exist at the pylorus, the abdominal palpator externally can move the pyloric end over in front of the gastroscope, unless there are extensive adhesions. The greatest usefulness to the surgeon is in the early diagnosis of malignancy (Figs. 17 and 18, Plate II). A specimen of growth can be removed with ease and precision by anyone who is experienced in œsophagoscopy. Gastric ulcer (Fig. 15, Plate II) has been diagnosticated and located in many instances. The condition as well as the patulency of any gastroenterostomic opening can be determined in a few minutes as was first done by the author in consultation with Dr. Wm. L. Rodman on one of the latter's patients.[1] The œsophagogastroscope shown at *H*, in Fig. 198 can be passed in one minute into the stomach of any patient with a normal œsophagus and whose mouth can be opened. The procedure is without mortality in careful and skilful hands. The only deaths occurring in 1000 cases by various operators were attributable to perforation of the œsophagus by several operators who had never learned œsophagoscopy, and all were in the early days of gastroscopy, before the absolute safety of the passage of the open tube by sight had been demonstrated by the author.

The instrument is passed into the stomach as already described under introduction of the œsophagoscope. Once the stomach is reached the exploration proceeds in the collapsed stomach by commencing at the left end of the stomach and inserting the œsophagoscope until the greater curvature is reached. Then the tube-mouth is moved about 1 cm. to the right and withdrawn to the cardia. It is then moved to the right another centimeter and pushed gently downward again until the greater curvature is reached. Thus the mucosal lining of the stomach is examined just as the field of the microscope is searched with the mechanical stage. A window may then be inserted in the proximal

[1] American Journal Medical Sciences, July, 1908.

end of the gastroscope, and the stomach inflated, as suggested by Mosher; or the lens system gastroscope of Janeway may be inserted through the safely passed open tube.

The open-tube gastroscope (*H*, Fig. 198) is very useful for the removal of dangerous foreign bodies, such as open safety pins, glass, etc., from the stomach. In case of very small foreign bodies, a fluoroscopist with the double-plane fluoroscope, perfected for the author by Dr. George W. Grier, will be of great assistance. The gastroscopist works with all the safety afforded by direct vision, while following with the tube-mouth the verbal guidance of the fluoroscopist.

The gastroscope, *H*, Fig. 198, is very useful in enabling the œsophagoscopist working through the mouth to give the abdominal surgeon whose hands are in the abdominal cavity, information as to the condition of the interior of any suspected portion of the stomach which the surgeon desires to place in front of the gastroscope. This has been used by J. Hartley Anderson for the identification of a bleeding point in the case of a bleeding gastric ulcer. In working thus it is necessary for the œsophagoscopist to have a separate sterile organization entirely apart from the sterile organization of the abdominal operator.

INJURIES OF THE ŒSOPHAGUS

Injuries of the œsophagus from within are usually inflicted by foreign bodies or attempts at removal. The best treatment is bismuth subnitrate given dry on the tongue. Calomel may be added from time to time. Food should be sterile liquids for five days, unless there is a mediastinal or pleural perforation, in which case nothing should be given by mouth. Water starvation may be prevented by enteroclysis, but rectal alimentation is so unreliable that a gastrostomy is justifiable. If the foreign body has invaded the pleura, immediate thoracotomy is indicated for drainage as well as extraction. Corrosive poisons, such as lye or acids, require an antidote followed by bismuth subnitrate taken dry. Burns and scalds should also be treated by bismuth. It is not usually advisable to pass an œsophagoscope during the acute stage of endoœsophageal injuries. For the subsequent stenosis œsophagoscopic treatment, as elsewhere herein given, is by far the safest and most effective form of treatment. Practically all stenotic cases can be cured. The first œsophagoscopic examination may be made at the end of two or three weeks.

Injuries of the œsophagus from without never occur without extensive injury of surrounding structures. Perforations by missiles and

projectiles, stab wounds, and the like usually require cleansing, removal of foreign matter, and suture of the external wound, or drainage, as conditions seem to indicate. If there is a large open laceration of the neck involving the œsophagus, the œsophageal laceration should be separately sutured first, invaginating the edges. In all such cases the breathing should be watched. Dyspnœa, which may be due either to laryngeal œdema or bilateral laryngeal paralysis, demands immediate tracheotomy.

ANOMALIES AND DEFORMITIES OF THE ŒSOPHAGUS

Anomalies.—The most common congenital anomaly of the œsophagus is in the form of a tracheoœsophageal fistula. Such an infant rarely lives because of other coincident malformation. If it survive for a time, food going into the lungs soon gives rise to a bronchopneumonia. A few instances have been recorded where a valve-like fold of mucosa prevented the leakage. It is not uncommon for the œsophagoscopist to find unexplained narrowings in the œsophagus of adults and, as suggested by A. Brown Kelly, some of these may have been a congenital narrowing whose lumen was not sufficiently small to prevent adequate swallowing of food.

Congenital webs of the œsophagus and other narrowings are readily dilated with the œsophageal bougie used through the œsophageal speculum, Fig. 246, or the œsophagoscope, *H*, Fig. 198. Being done by sight, there is practically no danger unless an undue degree of force be used. Such congenital contractions rarely recur after divulsion.

The œsophagus may be bifid, or may end in a blind pouch, its continuation being a cord-like structure without lumen connecting the pouch with the pervious œsophagus below. Such a condition has so far not been amenable to any form of treatment.

STENOSES OF THE ŒSOPHAGUS

Stenoses of the œsophagus may be due to compression by any form of periœsophageal disease, or to cicatricial, spasmodic, or neoplastic constrictions of the œsophageal lumen.

Paralysis of the œsophagus should be mentioned in connection with stenotic diseases, for, while not strictly a stenosis, it produces the same symptoms inasmuch as the patient is unable to swallow even liquids, in severe cases. Strange as it may seem, gravity plays no part in swal-

lowing. A man can swallow "uphill" with his mouth lower than his stomach, with ease; but, erect, he cannot swallow "downhill" unless the muscular apparatus of the œsophagus is in good working order. This phenomenon doubtless comes from the phylogenetic recency of the upright posture.

The most frequent causes of compression stenoses are aneurism, malignancy, auricular or aortic enlargement, lymphatic infiltration or calcification and lordosis. Bassler has reported a case due to hypertrophy of the auricle; Kahler one of compressive stenosis from cancer of the liver; and Gottstein one from pressure of a calcareous area in the pleura. The diagnosis is readily made by œsophagoscopy, which shows a normal mucosa with a lumen compressed by a mass external to the tube (Fig. 14, Plate II). The lateral extent of the mass will often be shown by radiography. Fluoroscopy is the best method of diagnosticating aneurism, the presence of which is a contraindication to œsophagoscopy.

The treatment will depend on the nature of the compressive disease so far as any attempt at cure is concerned. Palliative treatment by œsophageal intubation has yielded excellent results. The method is described under Malignant Disease of the Œsophagus.

Spasmodic Stenosis.—The most frequent form of spasmodic stenosis is due to contraction of the cricopharyngeus. It is one of the conditions that produces the symptom called "globus hystericus." In some instances the stenosis is so severe that the patient suffers seriously from inanition. This form is readily cured by a single passage of the œsophagoscope of large size, in all cases that are not really hysterical. True hysterical conditions are prone to recur, but they are very much rarer than the true form of spasm, erroneously labeled "globus hystericus," and which is often unassociated with difficulty in swallowing.

Hiatal Œsophagismus (*so-called "Cardiospasm"*).—Until demonstrated œsophagoscopically it was common to call these cases "cardiospasm," under the mistaken idea that the spasm existed at the cardia where a sphincter was supposed to exist. As demonstrated by the author,[1] the spasm is at the hiatus and not at the cardia.

The diagnosis formerly was inferential and often erroneous. Today the diagnosis is very readily made with absolute certainty by the passage of the œsophagoscope which reveals a large dilatation of the thoracic œsophagus, the mucosa showing a whitish, furred, macerated epithelium

[1] Chevalier Jackson. Tracheobronchoscopy, Œsophagoscopy and Gastroscopy, 1907. Ibid., International Medical Congress, 1913, Section XV.

EXPLANATION TO PLATE II

1. Introitus œsophageus. Normal. Dark line must not be understood as a gaping. Lumen collapsed shut. Man of 36 years. The fold of the cricopharyngeus is advanced from the posterior wall.

2. Intrathoracic œsophagus. Unusual view, but normal. More usual appearance is with radiating folds as in Fig. 10.

3. Œsophagus at hiatus œsophageus, normal. Note axis of lumen. Man of sixty. More usual appearance is a tightly puckered rosette.

4. Cicatricial œsophageal stenosis. Pin-hole lumen. White linear scars seen in perspective. Recurrence of stenosis following ulceration during typhoid fever. Primary lesion, burned by swallowing lye in childhood, 14 years previously. Man aged 21 years.

5. Bottom of diverticulum. Mucosa chronically inflamed. Man aged 64 years.

6. Tuberculous ulceration posterior œsophageal wall, simulating decubitus ulcer often seen in typhoid fever. Tuberculous lesions in this location are somewhat rare, though still more rarely are they diagnosticated. Incidentally this figure shows the introitus œsophageus when the cricoid cartilage is lifted by the laryngeal speculum. The ulcer is on the edge of the cricopharyngeal fold.

7. Carcinoma of the thoracic œsophageal wall (left) covered with normal mucosa. The lumen, crescentic in shape, is pushed to the right and almost obliterated. Man aged 60 years.

8. Carcinoma, endœsophageal. Woman of 41 years, referred for chronic nasal sinus disease. Œsophageal symptoms slight and attributed to "globus hystericus."

9 and 12. Fibroma papillare, attached by long slender fibrous peduncle. Disappeared into the œsophagus at times after swallowing. Fig. 12 shows the attachment within the œsophagus when the cricoid cartilage is moved forward (instrument not shown). Removed through direct laryngoscope. Man aged 36 years.

10. View in thoracic œsophagus showing wounds (direction of 12 o'clock) made by blind groping with a coin extractor which did not extract. Boy of 14 years.

11. Wound in œsophageal wall made by a pin. Woman of 23 years.

13. Normal. "Kink" and normal spasm of the œsophagus at the hiatus, probably more a preventive of regurgitation than the cardia. When tube-mouth is moved over the opening at the left, the hiatus will appear as a tightly puckered rosette, and then will open to gentle pressure with the œsophagoscopic tube-mouth.

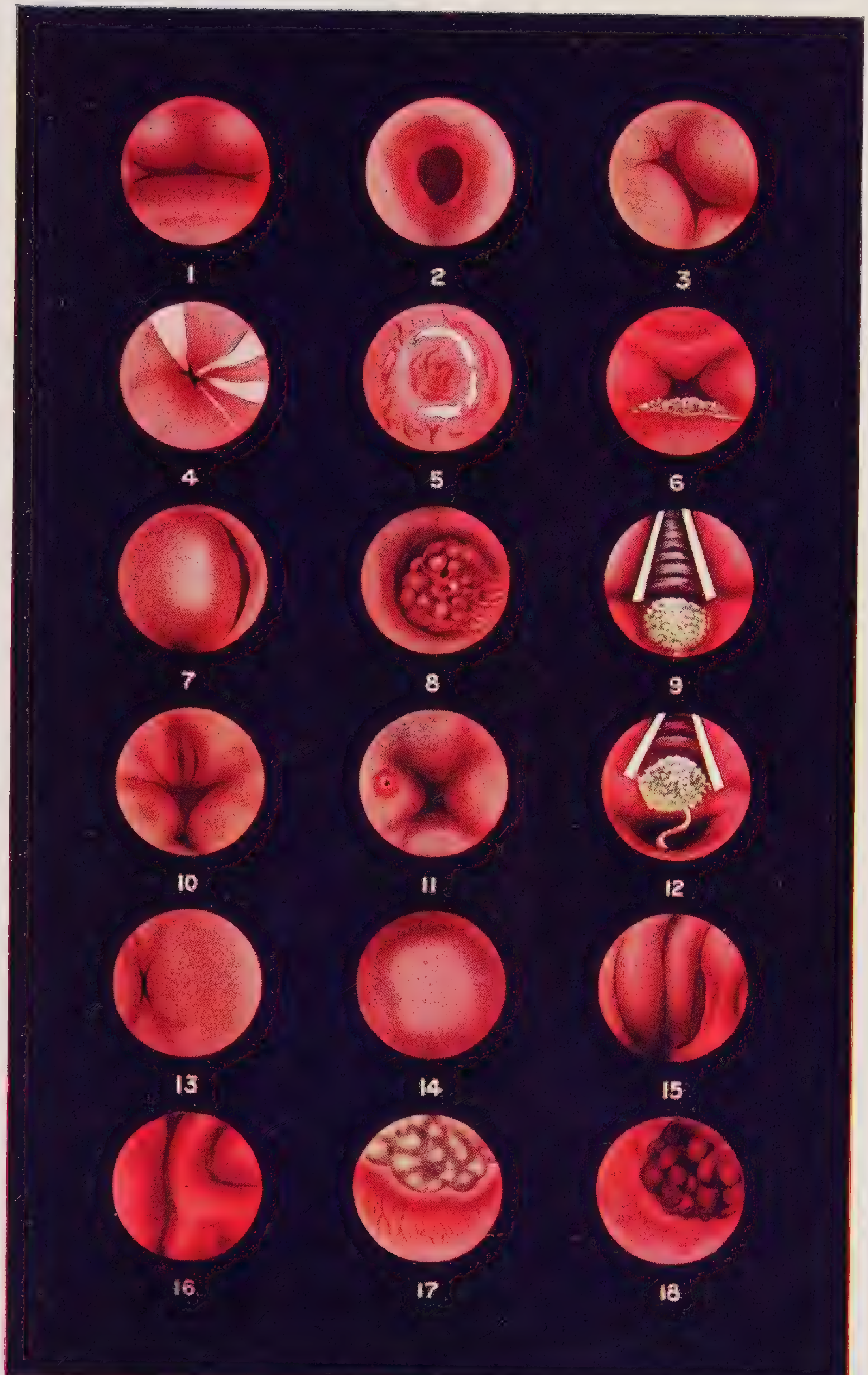
14. Periœsophageal carcinoma overlaid with normal mucosa, lumen deviated so far to right as to be out of view. Diagnosis correctly made upon hardness of mass, and age of the patient. Man of 60 years.

15. Stomach ulcer (on left side of right fold in the view), bed showing dark after secretions had been wiped away. Other folds normal. Woman aged 26 years.

16. Stomach. Normal. Fold on greater curvature. Dark crimson color. Examined one hour after drinking milk. Man of 32 years.

17. Stomach. Ulcerating carcinoma. Zone of hyperemia. Man of 46 years.

18. Stomach. Same patient. Mulberry-like nodule at another portion of growth.



Reproduction of water-color drawings. (*Chevalier Jackson.*)

covered with a pasty coating which does not wipe away. Usually food is contained in the dilatation even though the patient has been on liquids for a long time. When the bottom of the dilatation is reached, the hiatus must be searched for and will be readily found by the œsophagoscopist who is familiar with its appearance. It is usually a tightly closed, rosette-shaped depression with radiating folds. Gentle pressure with the distal end of the œsophagoscope for a few seconds will cause it to yield and the œsophagoscope will glide readily through into the stomach. The abdominal œsophagus and cardia never offer any resistance to the œsophagoscope if the direction of the axis of the tube is made to correspond with that of the abdominal œsophagus, as explained under Œsophagoscopy. Radiography is a valuable aid as showing graphically the superjacent œsophageal dilatation; and radiography and œsophagoscopy should go hand in hand.

Treatment consists in dilatation of the area subject to spasm. Various forms of dilating water bags and air bags have been used. They are efficient if they can be placed in the desired location. Many operators have found that the dilating bags after inflation were in the diffuse dilatation and not in the spasmodically stenosed location at all. Other observers have found it impossible to introduce the bags through the hiatus. The author's preference is for a steel instrument, such as that of Mosher. This can be put in place with great accuracy under ocular guidance, by means of the œsophagoscope (*H*, Fig. 198), and the spasmodically stenosed area can be over-stretched exactly as desired, preferably very slightly beyond the normal size. There can be no shifting of the rigid steel instrument during dilatation.

Cicatricial stenosis of the œsophagus is, in most instances, due to the swallowing of corrosive substances, such as solutions of lye, washing powders, ammonia, acids, etc. (Fig. 4, Plate II). Less common are the cicatrices following the traumatism of foreign bodies, breaking down of gummata, the ulceration of lues and tuberculosis, and the complicating mixed infections. Kyle reports a slight stenosis following the lodgment of a tooth-plate which had been *in situ* in the œsophagus for 17 years before he removed it. The stenosis was subsequently cured œsophagoscopically.

The diagnosis can be made in a few minutes by œsophagoscopy which gives all the safety and precision afforded by direct vision. The lumen of the stenosis may be found to be a mere pin hole or a number of millimeters in size. In some instances there is no lumen, the lumen of the œsophagus having been entirely obliterated.

If the patient is in a serious state of food starvation, an immediate gastrostomy should be done because any form of treatment requires time to produce results, and these results are more quickly obtained after the cure of the chronic œsophagitis due to the stagnation of food and maceration of the mucosa. All forms of œsophagitis usually disappear within two weeks after a gastrostomy if no food is given by the mouth. Water may be taken occasionally for cleansing the œsophagus. Most strictures are readily dilated by means of the filiform bougie

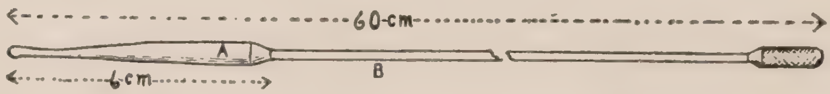


FIG. 252.—Filiform silk-woven bougie on steel stem for dilatation of cicatricial œsophageal strictures under œsophagoscopic guidance of the eye. (*Jackson.*)

(Fig. 252) passed through the œsophagoscope. If, however, there are a number of strictures one below the other and they are not concentric with each other, they must be dilated seriatim from above downward. This is best done with the mechanical dilator (Fig. 253) which has the advantage of dilating at its extreme point. When the upper stricture is dilated a small œsophagoscope may be inserted through it in order to find the lumen of the next stricture below, which is dilated in turn, and so on downward through a third and even fourth stricture. Plummer and Sippey advocate for adult patients the passage of bougies over a string guide. The patient swallows a string a day or two beforehand and when the lower end has passed through the stricture and through the stomach into the intestines sufficiently far so that traction can be made on the end projecting from the mouth, an olive bougie with an eye is threaded over the string. Increasing sizes of olives follow. Mixter, who was the first to advocate string swallowing, used the string as a saw after doing a gastrostomy to get hold of the lower end.

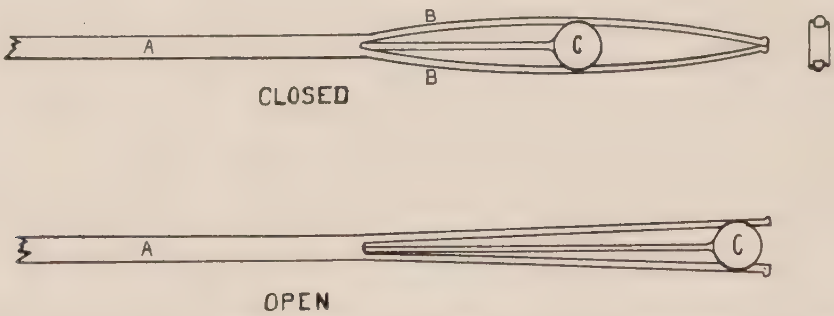


FIG. 253.—The author's œsophageal divulsor for the dilatation of cicatricial œsophageal strictures. Its greatest divulsive effect is at the point; therefore, it can be used to divulse seriatim a series of eccentric strictures too close together for other instruments to be entered.

Diverticulum of the Œsophagus.—Traction diverticula, which are due to the contraction of cicatrices adherent to the œsophageal wall,

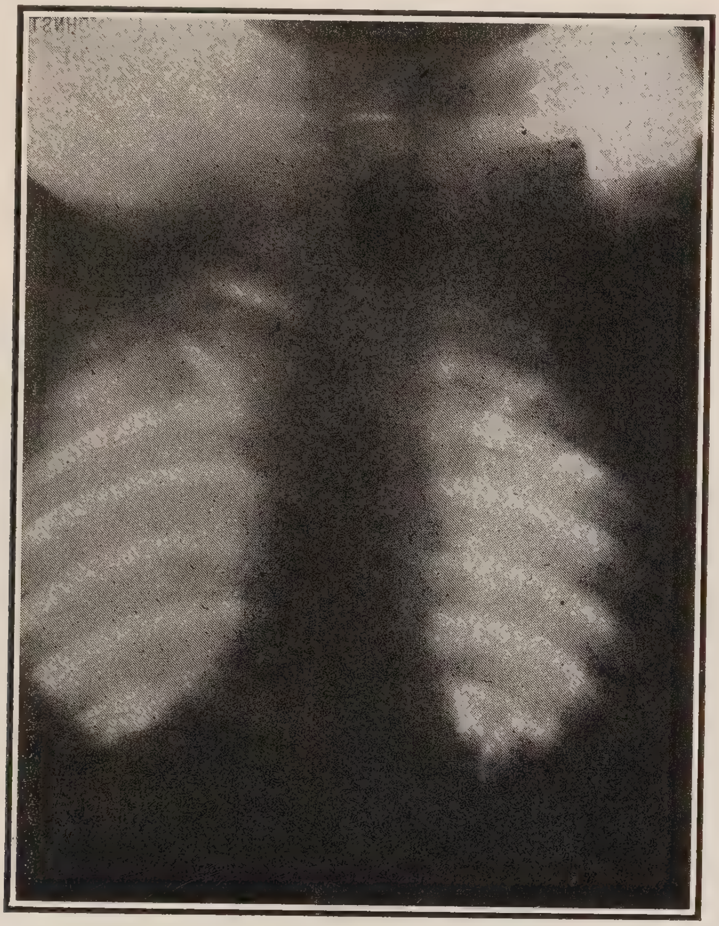


FIG. 254.—Radiograph showing bismuth-filled pulsion diverticulum in a man 67 years of age. Diverticulum (Fig. 255) removed by Dr. Otto C. Gaub by the Gaub-Jackson operation, Fig. 256. (*Radiograph made by Pancoast.*)

are usually located in the thoracic œsophagus. They are of no surgical importance because they produce no symptoms. Pulsion diverticula, on the contrary, produce most marked symptoms and soon result in serious inanition from difficulty in swallowing. They are always located in the neck and always start at the unsupported œsophageal wall between the circular and the oblique fibers of the cricopharyngeus, as demonstrated by Killian. The condition constitutes a hernia of the œsophagus. The patients usually complain of difficulty in swallowing, cough and expectoration of food, and a gurgling sound on swallowing. Pressure on the side of the neck will elicit the

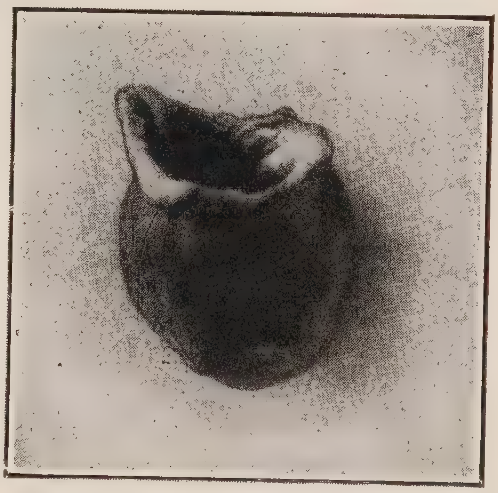


FIG. 255.—Diverticulum removed by the Gaub-Jackson operation, from a man of 67 years.

gurgling sound if the mouth is held open, as discovered by Boyce on one of the author's cases. The diagnosis is readily made by œsophagoscopy and by a bismuth radiograph. Radiography after a bismuth meal shows the shadow, as in Fig. 254, but taken alone it might occasionally lead to serious error, as shown in Fig. 256. No case should be operated upon until after both radiographic and œsophagoscopic study. Some cases have a more or less strictured cicatricial subdivertricular opening, and unless this is divulsed, cure will not follow excision

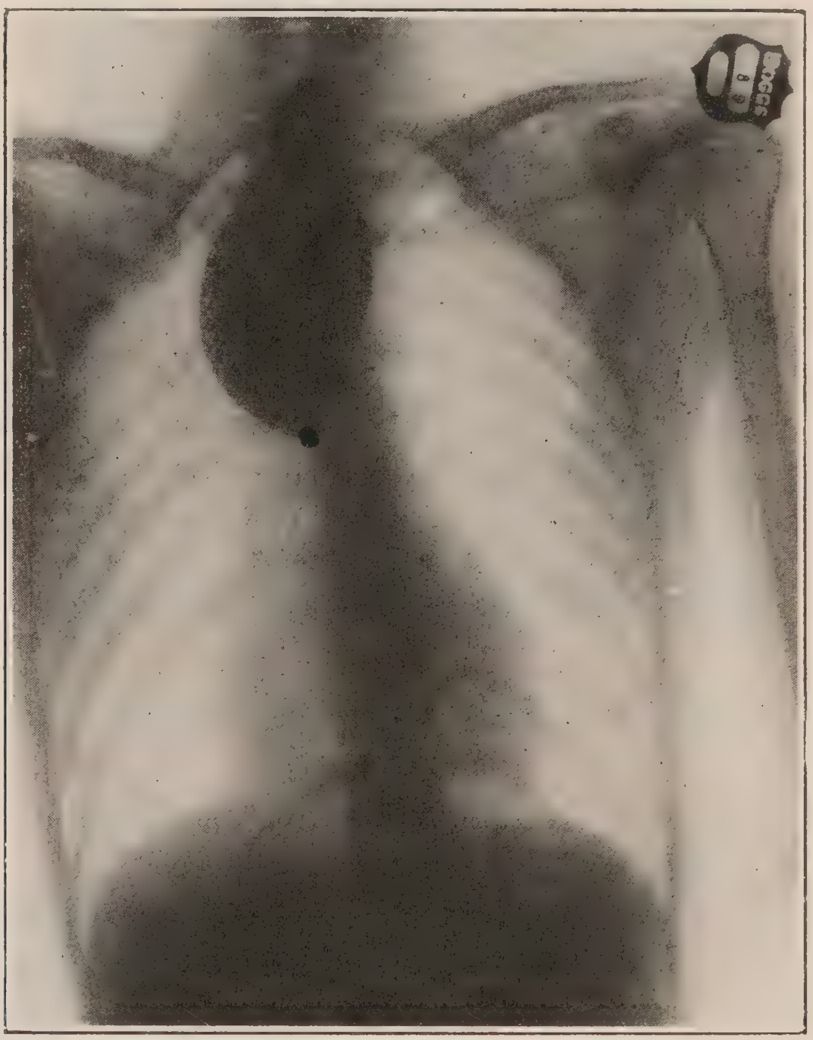


FIG. 256.—Radiograph showing a dilatation simulating a pulsion diverticulum. A cicatricial stricture of luetic origin, discovered by œsophagoscopy, fails to show because it is up back of the dilatation. Œsophagoscopic divulsion with the bougies, Fig. 252, resulted in perfect cure. (*Author's case. Radiography by Dr. Russell H. Boggs.*)

of the diverticulum. Blind methods of diagnosis, by bougie and laboratory methods with test meals, are obsolete. Œsophagoscopy, which gives the absolute certainty of ocular inspection, requires but a moment, and is done without any anæsthetic, general or local. On passing the œsophagoscope, the pouch of the diverticulum is found to constitute a continuation of the pharynx. The subdiverticular opening is nowhere visible and must be searched for along the anterior wall.

When found, the œsophagoscope is inserted in it and the nature of the diverticulum becomes fully demonstrated. A slanted-end œsophagoscope or the œsophageal speculum is best for this. The mucosa lining the diverticulum is practically always in a state of chronic œsophagitis (Plate II, Fig. 5).

The treatment consists in extirpation. If left to itself the diverticulum will increase in size until the pouch, when full of food, compresses the œsophagus below and prevents swallowing, resulting in serious or fatal inanition. Extirpation looks, in the radiograph (which shows the diverticulum distended with food), to be a very easy procedure. When operated, however, the diverticulum must necessarily be empty, and in its collapsed state a small diverticulum has been overlooked by the most skilful surgeons. Partial removal fails to cure symptoms and invites recurrence. Removal of the œsophageal wall has caused stenosis. To prevent these possibilities, as well as to expedite the operation, the Gaub-Jackson operation is now used. Its technique will be readily understood from the schema (Fig. 257). The external part of this operation is described under the head of external œsophagotomy.

External Cervical Œsophagotomy.—Insufflation intratracheal anæsthesia should always be used for this operation because respiration is very apt to be interfered with, either by traction on the œsophagus or by adductor spasm of the vocal cords due to irritation of the recurrent or the pneumogastric nerves. The head is extended and the left side of the neck, which is uppermost, is rendered prominent by a sand bag. An incision is made along the anterior edge of the left sternocleidomastoid ridge. The deep fascia is divided and the muscle is drawn aside along with the blood-vessels and nerves. The thyroid gland is retracted toward the median line. The landmark to bear in mind is the cricoid cartilage. A large vertical extent of wound must be made and must be kept clean and dry by careful hemostasis. The cricoid cartilage and, below it, the rings of the trachea must be seen. Posteriorly the œsophagus is seen as a thin flat fold pressed against the cervical vertebra. If it is desired to open the œsophagus, the latter is drawn out with silk sutures and isolated from surrounding structures with gauze pads before opening. If the intention is the amputation of a diverticulum, the œsophagoscopist is asked to push out the diverticulum into the wound. The bottom of the pouch is seized with forceps (Fig. 257). Then the œsophagoscopist inserts his œsophagoscope into the subdiverticular lumen of the œsophagus, and the surgeon amputates the redundancy, being careful not to make undue tension

lest there be a scarcity of tissue with resultant stricture. The surrounding structures are thoroughly bulwarked by inflammatory adhesions. The wound in the œsophagus may be united in three layers, the mucosa first, then the muscle and then the external coat. Or any form of invaginated suture may be used. Supporting sutures are inserted wherever possible, and the entire external wound is closed with the exception of a small drain inserted at the most favorable point. The drainage should be removed as soon as possible. Feeding should be by soft

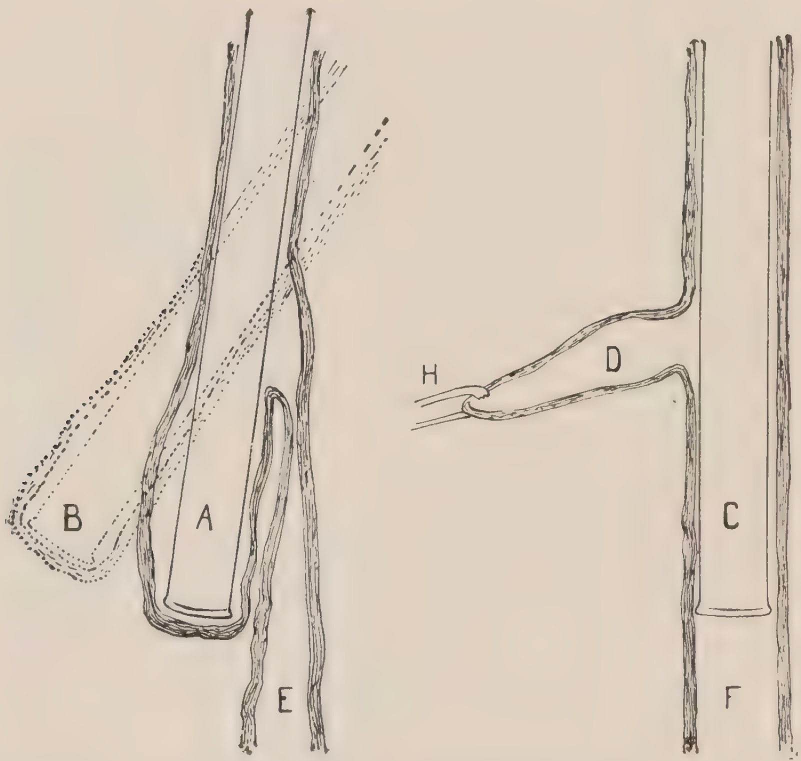


FIG. 257.—Schema showing Gaub-Jackson operation for excision of œsophageal diverticulum. At *A*, the œsophagoscope is represented in the bottom of the pouch after the surgeon has cut down to where he can feel the œsophagoscope. Then the œsophagoscopist causes the pouch to protrude as shown by the dotted line at *B*. After the surgeon has dissected the sac entirely free from its surroundings, he makes traction upon the bottom of the sac, as shown at *H*, while the œsophagoscopist inserts the œsophagoscope down the lumen of the subdiverticular œsophagus, as shown at C. The œsophagoscope now occupies the lumen the patient will need for swallowing. It remains for the surgeon to amputate the redundancy, without risk of removing any of the normal œsophageal wall, or risk of leaving part of the redundancy unremoved.

rubber tubes, carefully inserted. Primary union is usual. Should the wound break down, a free drainage tract must be maintained in as cleanly a state as possible. It may be freely irrigated by permitting the patient to swallow sterile water at frequent intervals. Peroxide of hydrogen may be advantageously added to the water. By measuring and subtracting the fluid which escapes externally from the total amount given, the amount of fluid swallowed can be determined (Otto C. Gaub). As soon as the fistulous tract becomes covered with granulations, sterile liquid food may be given, followed by copious draughts of

water to wash leakage from the tract. While leakage is usually discouraging to both surgeon and patient, it is really a beneficial thing, bulwarking against recurrence of the diverticulum by the support given by the inflammatory tissue. The fistula will usually close spontaneously in two or three weeks. If it should not, curettage should be used to prevent epithelialization of the fistula.

INFECTIVE DISEASES OF THE ŒSOPHAGUS

Pyogenic infections may follow the trauma of foreign bodies, but unless the wall is perforated and the infection escapes into the periœsophageal tissues, healing usually takes place promptly. The best treatment for these traumatic infections is bismuth subnitrate, given

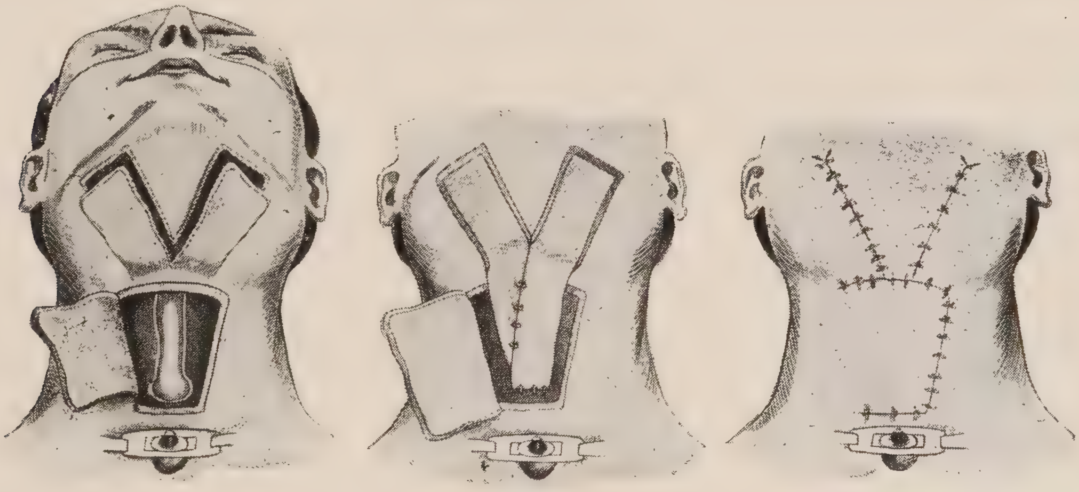


FIG. 258.—Autoplastic repair of the pharynx and upper œsophagus with submental flaps after partial œsophagectomy (and laryngectomy). The flaps are turned epidermal surface inward. The turning in of hair bearing epidermis should be avoided. (*Jackson.*)

dry on the tongue in small doses at frequent intervals, with the occasional addition of a little calomel. These act as local antiseptics and have remarkable power in controlling pyogenic infections.

Tuberculosis of the œsophagus is relatively rare but is seen in two forms: a superficial primary lesion, which is rare; and the erosion through of a mediastinal tuberculous lymph node. In either form recovery is the rule, if the patient's general condition is amenable to treatment. The regular antituberculous régime is curative and local treatment is unnecessary.

Syphilis of the œsophagus, while not common, is not so rare as was supposed prior to the days of œsophagoscopy. It may occur as a mucous plaque, or as a gummatous or ulcerative tertiary lesion. In either case it is amenable to general treatment. In extensive ulcerative

disease, as soon as healing has taken place, active œsophagoscopic bouginage must be undertaken to prevent cicatricial stenosis.

TUMORS OF THE ŒSOPHAGUS

Benign tumors of the œsophagus are quite rare. Tumors of inflammatory origin, not true neoplasms, such as edematous polypi associated with other lesions, benign or malignant, are relatively frequent. Granulomata are not uncommon. Angiomata, papillomata and fibromata (Fig. 12, Plate II) have been reported by a number of observers. These are all readily removed through the œsophagoscope by means of forceps, except in the case of angiomata, which are better dealt with by the galvano-cautery or by radium therapy.

Malignant Disease of the Œsophagus.—Malignancy occurs most frequently in the epitheliomatous form, though sarcoma and endothelioma are seen. The slightest difficulty in swallowing, in fact the slightest abnormal sensation in swallowing, should be considered an indication for an immediate œsophagoscopy. Unfortunately, however, the older methods of diagnosis were so very unreliable that malignancy was never discovered early enough to offer any hope of cure. The diagnosis is quickly made with the œsophagoscope if the lesion involve the œsophageal wall. The œsophagoscopic picture may be that of normal mucosa covering a hard infiltrated mass, with asymmetrical inspiratory enlargement of lumen (Fig. 7, Plate II), but usually ulceration and fungation are present (Fig. 8, Plate II). The removal of a specimen for biopsy is justified in any case and an ample one is readily taken with the forceps shown at *E*, in Fig. 198. Leucoplakia has been observed.[1] In other cases round nodular masses grouped in mulberry-like form, either dark red or light red in color, are seen. Œdematous polypoid masses frequently appear in the later stages.

The treatment of malignancy in the "party-wall," occurring as a post-cricoidal œsophageal cancer, is best extirpated along with the involved larynx at a laryngectomy, the œsophageal wall being afterward repaired as shown in Fig. 258. Hairs afterward growing from the inner surface of the flaps, in men, may require repeated removal with the œsophageal speculum. In men, when possible, cervical flaps free from hair should be used instead of submental flaps.

Intrathoracic malignant disease of the œsophagus is less amenable to surgical procedure, but Henry Janeway has devised an operation

[1] Chevalier Jackson. Peroral Endoscopy and Laryngeal Surgery, 1914.

which promises success, as soon as the necessary early diagnosis can be made. The wonderful development of œsophagoscopy without anæsthesia, general or local, without pain, and of only a few minutes' duration, now favors an early resort to œsophagoscopy for the necessary early diagnosis. The slightest abnormality in swallowing calls for immediate œsophagoscopy. The transthoracic operations are considered in another section of this work. Inoperable cases have been treated with excellent results by radium therapy, though, so far, these results have not justified their use in any case deemed operable. The equivalent of about 100 mgm. of radium element is necessary. It is placed in a metal capsule covered with hard rubber in order to screen out the alpha, beta, and secondary radiations. The capsule is attached to a hollow metal tube by means of a silk cord. This is passed down through the œsophagoscope and placed accurately *in situ*, for it is very necessary to know that the capsule is in contact with the growth and not with any normal tissue. When certain that the capsule will remain in place, the rod may be dispensed with and the silk cord left in the œsophagus for withdrawal. As a rule, however, it is better to leave the rod *in situ*. The radium must be kept in position for a time varying from half an hour to three or four hours. This dosage must be varied according to experience. The first effect noticed is the disappearance of the inflammatory condition due to mixed infections. Later the lumen enlarges, swallowing becomes easier and pain becomes less.

In any case of cancer of the œsophagus, the patient's nutrition must not be allowed to suffer. The necessity for gastrostomy can be postponed a long time by the use of intubation tubes which are easily placed through the œsophagoscope, being removed about once a week for cleansing. Under no circumstances should the patient's nutrition be allowed to suffer. If intubation of the œsophagus is not available, an early gastrostomy should be done, long before the patient has begun to suffer from food or water starvation.

SECTION XIX

THE THYROID

By

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History.—The diseases of the thyroid, especially "simple goiter," have attracted the attention of the medical profession for many years, but it is only within a comparatively recent period that hyperplasia of the gland and indeed many other pathologic conditions of the organ have been recognized as surgical. In 1786 Parry[1] described exophthalmic goiter with sufficient clearness to enable its recognition to be quite perfectly made. He was preceded by Morgagni,[2] who gave a fairly good description of its characteristics. Fourteen years later Flajani,[3] though apparently unaware of Parry's previous work, again called the attention of the medical profession to the symptom-complex which we know as "exophthalmic goiter." However, it was not until 1843, when Graves[4] published the lectures which he had been giving since 1835, that the description was accepted and the term "Graves' disease" applied thereto by English-speaking physicians. Three years before Graves' publication, but five years after Graves first began lecturing on the subject, von Basedow[5] published in German a clear description of the same symptom-complex which was later named in Germany "*Morbus Basedowii.*"

Charcot,[6] von Graefe,[7] Stellwag,[8] Marie,[9] Gunn,[10] Kocher,[11] Moebius[12] and others all contributed important observations to the literature concerning the various types of thyroid enlargement and the symptoms therefrom, up to 1886.

Since 1890, the literature has been so voluminous and so varied as to make a critical review beyond the limits of the present article.

Anatomy.—The thyroid is somewhat like a horseshoe in shape and rests on the trachea, with one lobe on each side, connected below by the isthmus which crosses the upper tracheal rings. These lobes are about 2 in. long, being smaller at the upper pole. The right one is usually the larger. The entire weight is from 1 to 1½ oz. The gland is invested by a thin fibrous capsule which divides posteriorly, one

portion lining the posterior and inner surface, while a part passes to the opposite side behind the œsophagus. This investment explains the production of pressure from tumor growths on both of these structures and the occasional appearance of tumors of the thyroid between them. Fibrous bands also unite the gland to the trachea, which causes the thyroid to move with it. Trabeculæ of connective tissue pass into the structure of the gland, subdivide into the framework for the alveoli and small vesiculæ, and serve as a skeleton for the lymph channels which extend throughout the gland. The lymph channels probably perform the function of excretory ducts, the larger number of them apparently emptying into the veins of the gland. The blood supply of the thyroid, considering its size, is remarkable for its extent and also for its freedom of anastomosis. No other organ in the human body is so well provided. All the blood in the body passes through the gland once an hour as it does through the brain. Tschuewski[13] has shown experimentally the amount of blood flowing through the thyroid per 100 gm. weight of the organ to be 20 cc. a gram per minute. He further shows the gland to be twenty-eight times as vascular as the head and five and one-half times as vascular as the kidney.

The superior thyroid artery from the external carotid supplies the upper pole on its inner side, dividing and entering the capsule. The inferior thyroid from the thyroid axis enters the capsule below at the hilus. Occasionally this artery is derived directly from the common carotid. The main veins are the superior, middle and inferior, although many others seem to develop in diseased organs. The nerve supply is derived from the sympathetic. In intimate relation with the inferior thyroid artery is the recurrent laryngeal nerve, which lies in the space between the trachea and the œsophagus, and is so often affected by pressure of tumors, by operation, or by scar tissue as to cause hoarseness. On the left side the recurrent laryngeal is usually more deeply set and not in such close relation to the artery.

The single anlage of the thyroid is first discernible as a prominence in the ventral wall of the pharynx between the first and second pharyngeal pouches. This invagination of the ectoderm becomes constricted, the hollow stalk of the vesicle forming the thyroglossal duct. The opening of the latter is soon incorporated into the anlage of the tongue and its lumen is obliterated, the foramen cæcum at the posterior part of the tongue marking its former opening. According to Gaskell,[14] the delivering duct of the thyroid persists in a number of the invertebrate animals. Gaskell[14] believes that in ammocœtes the organ is probably a

sex gland delivering into the genital tract. This sex relationship is marked throughout all animal life. Marine[11] has shown that of the five varieties of epithelium lining the endostyle of ammocœtes only one or two persist in the true thyroid developed therefrom in the adult animal. The anlage of the thyroid develops into a broad body composed of irregular cords of cells which become differentiated into individual groups of cells, the anlage of the follicles. These follicles may possess a lumen, although for the most part the lumina appear later and successively, even to some extent forming in the first years of childhood.

Anomalies of development are not unusual. There may be a total absence of the thyroid or the persistence of a rudimentary type of gland, as occurs in cretins. A portion of the gland may persist in its original location at the base of the tongue, forming a "lingual thyroid." During its descent into the neck, portions of embryonic thyroid may be detached, forming "aberrant thyroids." The most common anomaly is a stringing out of the fœtal thyroid by entanglement with the hyoid bone in its development, forming the "pyramidal lobe." Portions of the thyroglossal duct may remain patent and later in life cause "thyroglossal duct cysts," due to the activity of misplaced and uncontrolled embryonic mucosa.

Physiology.—The thyroid is a ductless gland or a gland of internal secretion. Its definite function is still an unsettled question. Certain physiologic facts are known. Absence of the thyroid, either natural or experimental, in young animals markedly retards their physical and mental development and inhibits the maturity of sex, producing the condition known as cretinism. Total removal of the gland in an adult animal causes marked mental and physical deterioration, resulting in a condition parallel to that known in man as myxœdema, a symptom-complex due to thyreo-priva. It is certain, therefore, that the thyroid plays a powerful rôle in the animal metabolism. Experimental hyperthyroidization has never yet proved successful, though certain symptoms of toxæmia are easily induced by feeding with thyroid.

It was shown by Baumann[16] that the thyroid contains a considerable amount of iodine in organic combinations. The iodine content varies greatly in different animals, being much less in herbivorous animals. It has been shown to vary with the amount of hyperplasia present in the gland. Iodine medication speedily increases the iodine content of the gland, and usually reduces, though it may increase, its size.

The thyroid is physiologically susceptible to various influences.

Its size is increased at the age of puberty in the female, so much so that in certain parts of the country almost all girls of high-school age have somewhat enlarged thyroids. These enlargements are so common that they must be considered as physiologic. They ordinarily subside after a few years. The gland enlarges with menstruation in many females, and also enlarges from various factors such as fright, sexual excitement, and some infectious diseases. In old age the gland becomes atrophied.

The recent work of Eppinger, Falta and Rudinger[17] on the physiology of the thyroid deserves mention. They contend that internal secretions of the thyroid, the pancreas and of the other organs of the chromaffin system represent a series of interacting inhibitory and excitatory influences. For the details of this work the reader is referred to the original articles.

Since Baumann's[16] observations an enormous amount of study has been put on the relationship of the iodin content of the thyroid to the physiologic activity of the gland by Oswald,[18] Marine,[19] Hunt,[20] Smith,[21] Kendall[22] and others. Kendall has recently pointed out this relationship as follows:

"During the past twenty years, investigation has firmly established, among other things, the following two facts: (1) The thyroid contains some substance capable of producing marked physiologic effects, and (2) iodin is a constant constituent of normal and pathologic glands. These two facts are emphasized because most of the controversies concerning the thyroid have arisen from attempts to explain the relation between the physiologic activity and the presence of iodin.

"It is obvious that no final conclusions could be arrived at until either some substance possessing physiologic activity had been isolated in pure form and shown to be a normal constituent of the gland, or until the compound containing iodin had been isolated in pure form and its physiologic activity determined.

"Last December (1914) I reported the separation from the thyroid of a preparation containing 60 per cent. of iodin. The present paper is a summary of the results thus far obtained. In brief, the compound containing iodin, the presence of which as a normal constituent of the thyroid was foretold by Baumann nineteen years ago, has been isolated in pure crystalline form, and further, it has been shown that this compound is the substance in the thyroid which is responsible for the physiologic activity of the gland.

"Previous investigation has shown that the compound containing

iodin is firmly held as a constituent of the thyroid proteins. Hence separation of this compound must be preceded by a breaking down of the proteins into the simpler constituents of which they are composed. Baumann attempted this hydrolysis, using 10 per cent. sulphuric acid, but no satisfactory cleavage of the molecule resulted. The hydrolysis which has been successful was accomplished with sodium hydroxid in alcohol as a medium for carrying out the process.

"A large number of compounds are obtained by this splitting up of the protein, but they are separated into two groups by the addition of

FIG. 259.—Compound containing 60 per cent. of iodin isolated from "*A*" in pure crystalline form.

acid. Those compounds insoluble in acid are designated Group *A*, and those soluble Group *B*.

"The total iodin in the gland is found to be divided almost equally between the two groups. By further hydrolysis of the *A* group the compound containing iodin has been separated in pure crystalline form. Its exact formula cannot now be stated, but it appears to be di-iodo-di-hydroxy-indol. It crystallizes in microscopic needles that melt around 220 C. It is very insoluble in alcohol, ether, water, acids and sodium carbonate. Dilute hydrochloric acid dissolves 1 part in about 200,000. It is readily soluble in dilute alkali and ammonia.

"No definite substance possessing physiologic activity has been isolated from the *B* group, but it is known to be a complex mixture containing amino-acids. The iodin in *B* is in organic combination, but the nucleus to which it is attached is unknown.

"The thyroid having been separated into several different constituents, it seemed desirable to test each one for its possible physiologic activity. It was found that the typical effects of administration of desiccated thyroid—a rapid increase in pulse rate and vigor, increase in metabolism with loss of weight, and increase in nervous irritability—are all produced by the *A* constituents.

"The next step showed that in *A*, containing about 5 per cent. of iodin, the effects produced are directly proportional to the amount of iodin present. And finally, in the purification of *A* and the separation of the iodin compound in crystalline form, the same typical effects were produced through all the various stages of purity, up to and including the crystalline compound containing 60 per cent. of iodin.

"In testing *B* for physiologic activity, it was found that no apparent effects are produced when *B* is given experimentally to a normal animal or human being, but that a considerable degree of activity is manifest when *B* is given to patients suffering from cretinism, myxedema and certain conditions of the skin. However, no toxic effects have been in produced by the administration of *B*, even in the large amount.

"This nontoxic effect of *B* is in strong contrast to the action of *A*. Although both *A* and *B* contain iodin, it has been shown that the toxicity of *A* is in direct proportion to its iodin content, but *B* iodin given in equal amount produces no apparent effect.

"As previous investigators have pointed out, it is not iodin, *per se*, that is necessary. This work shows that it is the iodized indol that produces the physiologic activity. The actual amount of the crystalline iodin compound necessary to produce marked effect is exceedingly small. A total of 11 mg. (one-sixth grain), given in divided doses during a period of fourteen days to a cretin weighing 40 pounds, increased the pulse rate from 90 to 140. A total of 30 mg. (one-half grain), given in divided doses over a period of eighteen days to a woman weighing 112 pounds, increased the pulse rate from 75 to 130. Not only in rate but also in apparent vigor of the beat the cardiogram of a heart, after administration of the iodin compound, simulates a cardiogram of a patient with exophthalmic goiter."

Pathology.—Wilson[23] briefly summarizes the pathology of the thyroid as follows:

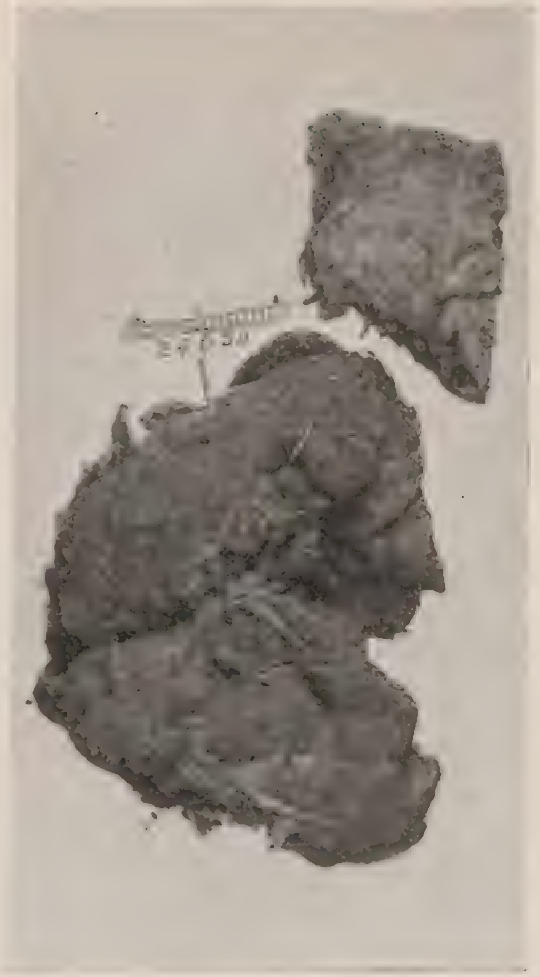

FIG. 260.

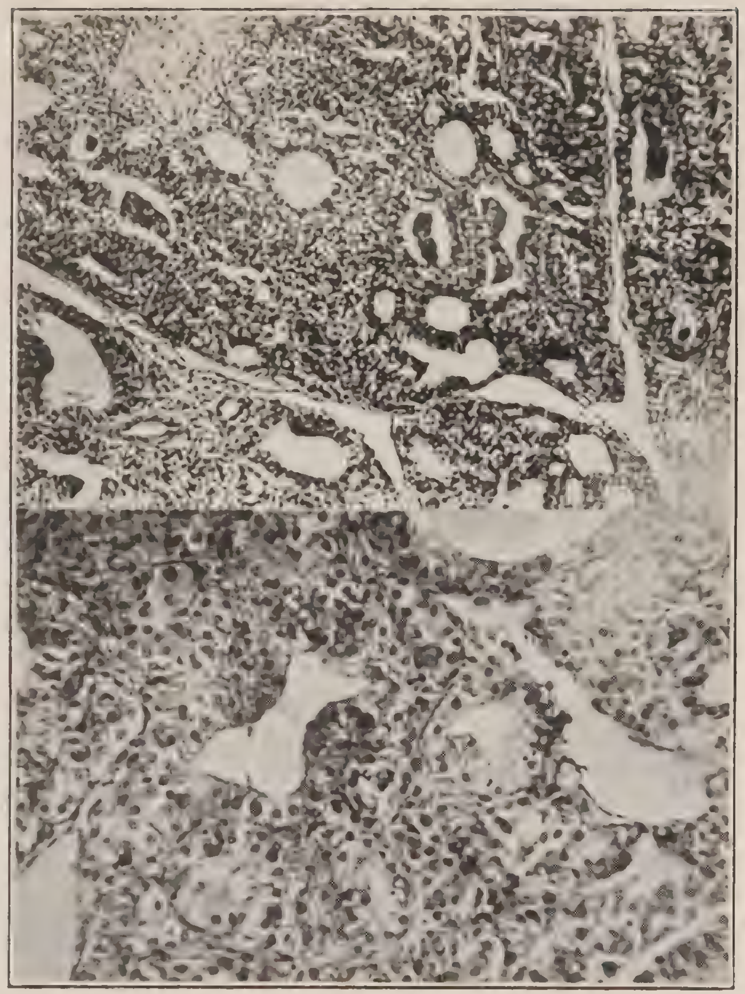

FIG. 261.

FIG. 262.

FIGS. 260, 261, 262.—Clinical diagnosis early exophthalmic goiter. Pathologic diagnosis: early primary parenchymatous hypertrophy and hyperplasia. Group A.

Fig. 263.

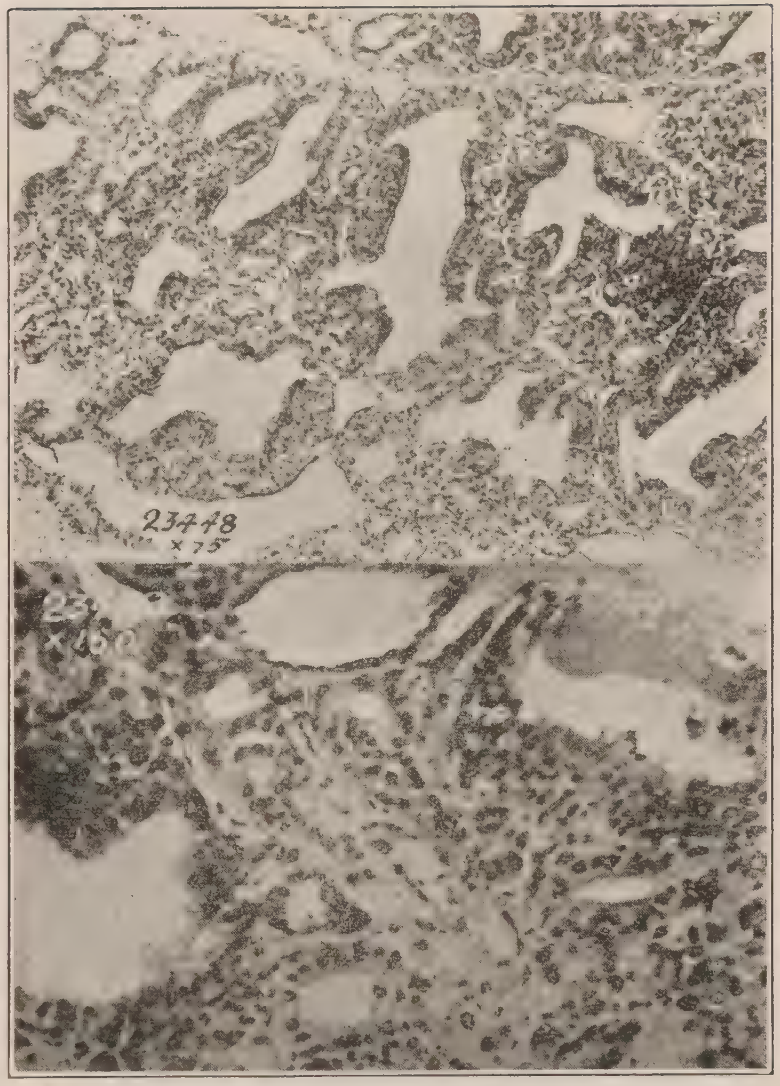

Fig. 264.

Fig. 265.

Figs. 263, 264, 265.—Clinical diagnosis: exophthalmic goiter advanced progressing pathologic diagnosis: advanced primary parenchymatous hypertrophy and hyperplasia group B.

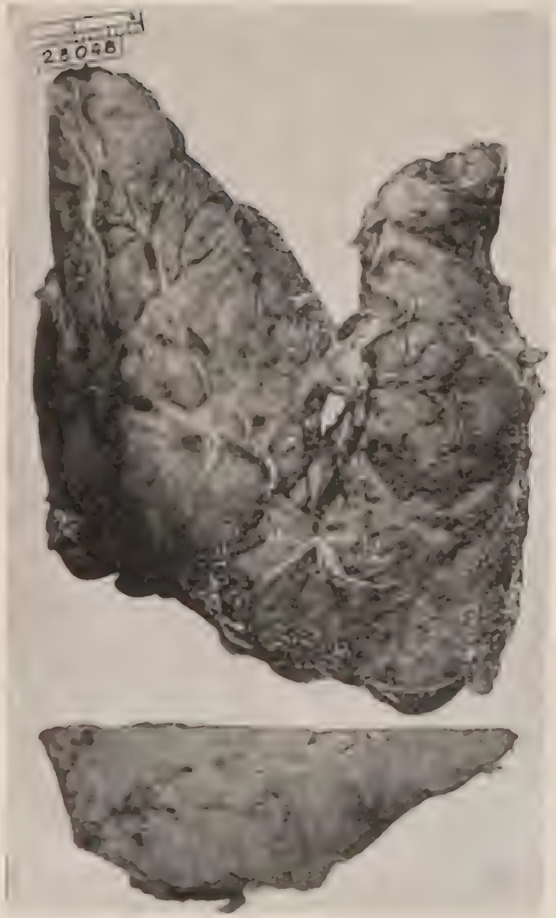

FIG. 266.

FIG. 267.

FIG. 268.

FIGS. 266, 267, 269. Clinical diagnosis: late exophthalmic goiter. Pathologic diagnosis: regressing primary parenchymatous hypertrophy and hyperplasia.

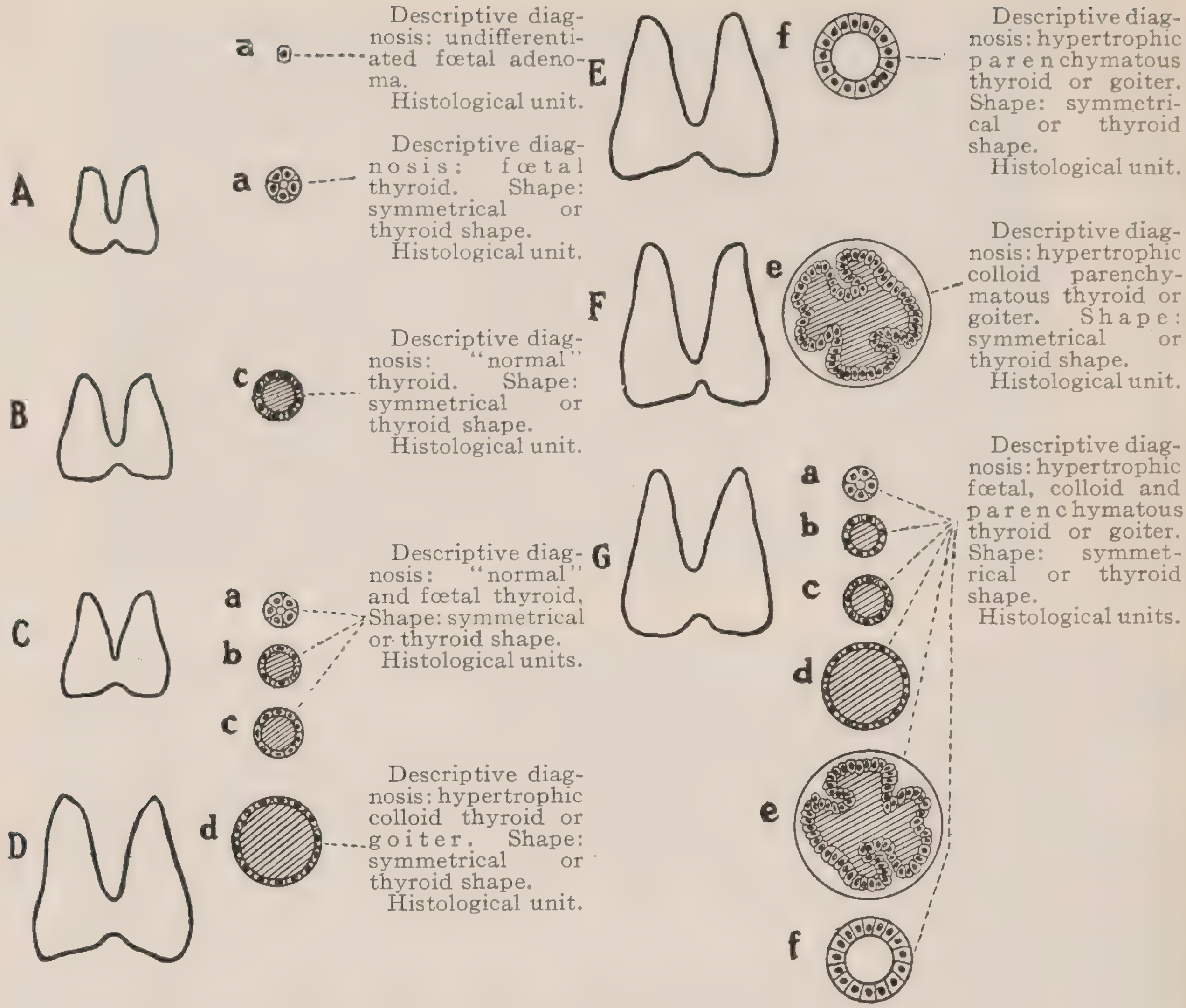

FIG. 269.—Symmetrical or thyroid-shaped thyroids or goiters. (*MacCarty's Surg., Gyn. & Obstet.*)

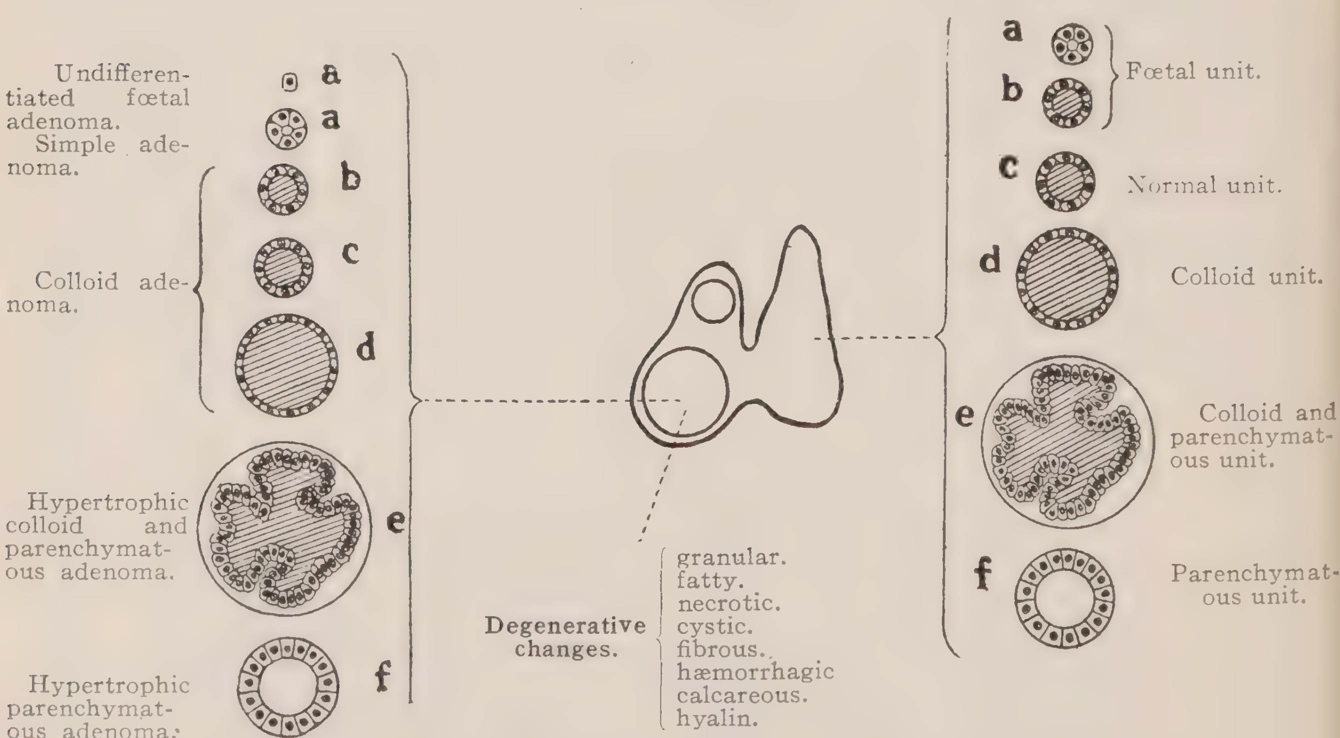

FIG. 270.—Asymmetrical or nodular thyroids or goiters. (*MacCarty's Surg, Gyn. & Obstet.*)

"The thyroid is a congeries of a great number of groups of cells which may be found even in the adult in any stage of development from masses of unarranged embryonic cells (Wölfler's rests) through tightly packed, centrically arranged groups of embryonic epithelial cells, to well-developed follicles lined with epithelium, evidently capable of secreting into the well-marked central cavity. With such a great variety in the stages of development of the epithelium of the gland existing even in the adult, in whom there are no symptoms of thyroid change, the pathologic changes produced may present an enormous variety, of which the following are the more important:"

"1. The simplest change which we find appearing upon the normal (resting) thyroid is hyperæmia. This is quickly brought about by excitement (sexual, fear, etc.) and is usually very fleeting. Yet we must remember that hyperæmia always materially increases the index both of secretion and of excretion of the gland."

"2. Associated with hyperæmia may be hemorrhage, which may be so extensive as to cause sudden and great enlargement of the glandular tissue and frequently results in secondary cyst formation."

"3. Acute inflammation of the thyroid may occur as the result of traumatism or as an incident in the course of a general bacterial disease."

"4. The most important pathologic changes in the thyroid, however, as related to goiter, are those concerning the parenchyma. The simplest of these is hypertrophy, which invariably and very quickly follows hyperæmia. The functionating cells of the parenchyma become swollen and columnar with nuclei approaching their free extremities; the acini become dilated and the secretion acquires lowered density, thus more readily passing into the circulation. Simple hypertrophy of the thyroid may result temporarily in secretion and excretion beyond physiologic limits" (Figs. 260, 261, 262).

"5. Progressive hyperplasia of the thyroid consists of an increase in the number of parenchyma cells—which are also almost invariably hypertrophic—either in the original single or in multiple new layers. Accompanying this is an overgrowth or stretching of the stroma or an infolding of the acinar walls with papillomatous growths into their cavities, providing basal attachment for the increased number of cells. The secretion in early hyperplasia has always a low density, which, however, rises as the increased function is prolonged. Many thyroids in cases of exophthalmic goiter show every portion of the gland in an active hyperplastic condition, all evidence of embryonic acini having

disappeared, and Wölfler's rests entirely absent or perceptibly crowded into lesser space by the pressure of the swollen epithelium of the acini. This condition is *par excellence* that associated with progressive toxic symptoms of exophthalmic goiter. Clinically, both lobes of the glands are affected and the enlargement is described as 'bilaterally symmetric,' though the right lobe is usually larger than the left" (Figs. 263, 264, 265.)

"6. Adenomatosis of the thyroid consists of a diffuse multiplication of the embryonic acini or the development of new acini from Wölfler's rests. Such a diffuse increase in the number of acini should be sharply differentiated from the formation of adenomas. Adenomatosis may be associated with hypertrophy or hyperplasia of the contained parenchyma and thus be the condition present in the thyroids in cases which develop toxic symptoms late in the course of simple goiter. Sometimes, however, the parenchymatous cells in the newly formed acini remain cuboidal and without hyperplasia."

"7. Regeneration of previously atrophied parenchyma is usually readily differentiated from primary parenchymatous hypertrophy and hyperplasia by (*a*) the abundant presence of atrophic parenchyma within large acini, (*b*) the development of numerous new acini within one or more portions of the walls of the old large colloid-filled acini and which early fill with dense colloid, and (*c*) the development of multiple layers of relatively small parenchymatous cells within the large colloid-filled acini which are to be distinguished from primary parenchymatous hypertrophy and hyperplasia by the smaller size of the parenchymatous cells and the absence of papillæ."

"8. True adenomas of the thyroid can be identified only when they are encapsulated. Histologically, they are of two types: (*a*) fœtal adenomas, in which the parenchyma is of true fœtal type, *i.e.*, consisting either of cordons, embryonic tubules, or more or less lumenless groups of spheroid cells or of combinations of these group units; (*b*) adult adenomas, which are encapsulated tumors in which the parenchyma has taken on adult characteristics, that is, it consists largely of spheroid follicles containing lumina lined with cells of adult type. The tissue of adult adenomas may take on all the changes which have been noted in the thyroid tissue outside the encapsulated tumors. While it may be true that adult adenomas develop from fœtal rests, there is insufficient evidence to demonstrate this beyond peradventure and, for both pathologic and clinical purposes, it is best sharply to differentiate the two on the lines indicated above."

"9. Of the retrogressive changes in the thyroid, retention of secretion is the most common and approaches nearest to the normal physiologic state. There can be no doubt but that the thyroid is not only an actively secreting organ, but that it has, normally, a storage function as well. It is impossible, however, to say what constitutes normal storage function. When, however, the retention of secretion has reached the stage at which by pressure, by enfeebled circulation, or by both, the material contained in the glandular acini is so dense that the index of absorption is obviously decreased and, when the parenchymal cells lining the follicles are flattened out and apparently no longer secreting, there can be no doubt that we have a pathologic condition. This extreme retention of secretion is the essential element in the formation of the so-called colloid or simple goiters. Some areas in such thyroids occasionally contain sufficiently active parenchyma that it may take on hyperæmia or hyperplasia (regeneration) and permit of even the somewhat rapid absorption of long quiescent colloid. Such a condition explains why we occasionally have, arising late in the history of old colloid goiters, a condition of acute though usually mild thyrotoxicosis" (Figs. 266, 267, 268).

"10. Atrophy of the parenchyma of the thyroid results, as elsewhere in the body, from overwork, pressure, and lack of nutrition. The cells, becoming flattened from pressure of retained colloid secretion, may die and desquamate from the acinar walls. This condition must be differentiated, however, from a rapid desquamation and disintegration of the parenchymal cells which occasionally occurs in the course of acute hypertrophy and hyperplasia. We have found this latter condition in a few cases which have been rapidly fatal. It appears to be exactly what one would expect in the case of an intense locally acting toxin."

"11. Of the terminal degenerations, aside from colloid—which is often overlooked—in both the parenchyma and stroma, hyaline, amyloid, and calcareous changes are not uncommon. These, however, appear to have no clinical significance other than that their presence indicates terminal stages of an old process."

"We may therefore classify the histologic conditions met with in the thyroid as follows:

I. Embryonic (undeveloped) thyroid.

II. Normal (resting) thyroid.

III. Vascular changes.

1. Hyperæmia.
2. Hemorrhage (including resulting cyst formation).

IV. Inflammations.

V. Progressive changes.
  1. Hypertrophy (functional, with hyperæmia).
  2. Hyperplasia ("exophthalmic" goiter).
  3. Adenomatosis (multiplication of acini without encapsulation).
  4. Regeneration of previously atrophied parenchyma.

VI. Retrogressive changes.
  1. Retention of secretion (colloid goiter).
  2. Atrophy (of parenchyma).
  3. Degenerations.
    (*a*) Colloid (of parenchyma and stroma).
    (*b*) Hyaline.
    (*c*) Amyloid.
    (*d*) Calcareous.
    (*e*) Cystic.

VII. Tumors.
  1. Benign.
    (*a*) Fœtal adenomas (encapsulated).
    (*b*) Adult adenomas (encapsulated).
  2. Malignant.
    (*a*) Mesotheliomas.
    (*b*) Carcinomas.
    (*c*) Sarcomas.

The preceding diagrams illustrate MacCarty's[24] hypothesis of the relationships of the histologic pictures met with in the thyroid (Fig. 270).

EXOPHTHALMIC GOITER

Clinical Symptoms.—Plummer[25] has recently called attention to the fact that clinically there are two distinct groups of toxic goiters; one exophthalmic and the other toxic but non-exophthalmic. "Exophthalmic goiter is a definite clinical complex always associated with hyperplasia of the thyroid and it should be sharply distinguished from the constitutional state or states that may develop with non-hyperplastic goiter" (Figs. 264, 267, and 270).

"For the purpose of quickly presenting the clinical pictures, let us note the parallelism of thyrotoxicosis and alcoholism and assume that there are three toxic elements in the thyroid secretion, one damaging

chiefly the nervous system, one the circulatory system, and the other producing exophthalmos. In exophthalmic goiter all three elements are in excess, but the clinical picture is dominated by a nerve toxin, although in individual cases the circulatory toxin or the element producing exophthalmos may seem to be in excess."

"The onset of exophthalmic goiter, is, as a rule, relatively acute and the course of the disease fairly definite. The clinical picture early in the history is that of a toxin acting directly on the more vital organs, more notably the central nervous and vascular systems. Later it is made more complex by the interaction of those organs whose functions have been directly disturbed by the toxin. The order of onset of the more important symptoms based on the average of our series is as follows: (1) cerebral stimulation, (2) vasomotor disturbances of the skin, (3) tremor, (4) mental irritability, (5) tachycardia, (6) loss of weight, (7) cardiac insufficiency, (8) exophthalmos, (9) diarrhœa, (10) vomiting, (11) mental depression, (12) jaundice, and (13) death."

"If the average course of the intoxication be represented by a curve the greatest height is reached during the latter half of the first year, and then suddenly drops to the twelfth month. In many instances it reaches the normal base line during the next six months. More often it fluctuates with periods of exacerbation for the next two to four years. Secondary symptoms and exophthalmos may remain, but the active course only rarely continues over four years without distinct intermissions. Compare the striking resemblance of the character, order of onset and course of this train of symptoms with that resulting from the heavy use of alcohol by a susceptible individual over a corresponding period of time. Near the crest of the curve any shock, operation, etc., that treats the patient to 'another drink' may result in tremens or death."

"In the average course after the first year the symptoms that may be attributed to long-continued intoxication rather than to a high degree of acute intoxication, *i.e.*, those from the more chronic types of heart, liver, and kidney degeneration, enter strikingly into the clinical picture. In attempting to construct a composite curve we find that the curves for those symptoms that we can readily attribute to a high degree of immediate intoxication from the thyroid gradually drop while the curves for those findings attributable to a long-continued intoxication of a lower degree gradually rise."

The eye symptoms are many. Graefe[7] noted the lagging of the upper lid in following the movement of the eyeball upon looking down.

Kocher[26] remarked the same in the lower lid on looking up. Stellwag[8] noted the staring without winking for long intervals.

Dalrymple[27] remarked the widening of the palpebral fissure. Moebius[28] discovered the diplopia with near vision in extreme exophthalmos. Landström[29] showed the exophthalmos to be due to effects of the sympathetic upon the non-striated muscles of the orbit which support the globe against the anterior supporting capsule and against which the voluntary muscles of the eyeball exert their pull.

Kocher[26] asserts that a marked lymphocytosis is characteristic of exophthalmic goiter. Our examinations show that, while this is true in many cases, it is not a constant finding and also that this condition of the blood is not infrequently met with in atoxic and in toxic-non-exophthalmic goiter.

Pathology.—Wilson[30] has shown that "not only is there a constant association of primary parenchymatous hypertrophy and hyperplasia of the thyroid with exophthalmic goiter, but that further both the clinical stage and the clinical severity of the disease may be estimated from the stage and severity of the pathologic changes. Thus the average ages of patients with early primary parenchymatous hypertrophy and hyperplasia (Figs. 260, 261 and 262) is 25 years at the time of operation, while they have had their symptoms for 0.3 years. The corresponding figures for patients whose thyroids show advanced primary parenchymatous hypertrophy and hyperplasia (Figs. 263, 264 and 265) is 31.7 years and 0.9 year respectively, while for those patients whose thyroids show regressing primary parenchymatous hypertrophy and hyperplasia (Figs. 266, 267 and 268), the corresponding periods are 40.7 and 3.5 years respectively." While various toxines may cause degeneration of the essential organs, *i.e.*, heart, liver, kidneys, etc., the toxin causing the symptom-complex which we designate thyrotoxicosis must be associated with definite pathologic changes in the thyroid, for example, hypertrophy, hyperplasia, etc., in order to prove its origin therein.

Treatment.—Some cases of mild exophthalmic goiter recover spontaneously, others yield to careful hygienic treatment, which consists essentially of rest, quiet, mild exercise in the open air, reduced nitrogenous diet, etc. Specific medication for exophthalmic goiter has been largely based on the assumption that the symptoms are due to the absorption of a toxin from the gland and efforts have been made to neutralize the toxin or to immunize the patient against its effect. The milk (evaporated milk—Rüdigen's) or the serum of thyroidectomized goats used by Moebius[31] administered internally has not met the expecta-

tions of its originator. The cytotoxic serum prepared by Beebe and Rogers[32] after the plan of Kocher has been more successful in the early stage of hyperthyroidism, though it is uncertain in its results even in the hands of its originators. The mortality under this treatment is higher in the cases of true exophthalmic goiter than under combined medical and surgical methods. By cytolysis it should and does make the thyrotoxic goiter worse.

The administration of iodin both internally and externally is one of the oldest forms of medical treatment for goiter. Clinically, while it often acts well, especially in the œdematous goiters of young people, it frequently makes the condition worse (especially is this true of exophthalmic goiter) and our data show that rules for its proper administration are still undetermined. Its use in patients between the ages of 35 and 60, suffering from goiter of long-standing seems to cause an overstimulation with rapid degeneration and thyrotoxic symptoms causing degeneration of heart, kidneys, etc. In relation to the surgical treatment of exophthalmic goiter of severe intoxication, it must constantly be borne in mind that we are dealing with a chronic disease regularly presenting improvement followed by exacerbation of symptoms. In the severe cases growing worse, operation must not be performed. These cases are for a time medical and emergency surgery is not indicated.

As a preparation for thyroidectomy in severe cases of hyperthyroidism, the use of the Röntgen ray will sometimes cause a temporary amelioration of the more severe symptoms. In the preparation of very serious cases of this type the injection of 1, 2 or 3 dr. of boiling water (Porter's[33] method) into a lobe of the gland acts favorably in improving the condition of the patient so that a ligation may be accomplished which will permit the ultimate removal of a portion of the gland.

Operative Treatment.—Ligation.—The earliest ligation of vessels for the relief of goiter is credited to Wölfler.[34] Our experience with this procedure covers more than 20 years and about 1000 operations. With the results obtained by this method we consider that the ligation of vessels and at times of a portion of the gland seems indicated in certain cases. First, in those patients suffering from mild symptoms of hyperthyroidism which are hardly severe enough to warrant a thyroidectomy, the ligation of the vessels will often produce a cure in a few weeks with but little risk and without the necessity of special medication. Second, ligation is indicated in that large group of patients having acute, severe

exophthalmic goiters and in the chronic and very sick patients, who, having exhausted all forms of treatment, are now suffering from various secondary symptoms. Ligation is also of particular value in those cases of marked pulsation and thrill of the thyroid arteries associated with dilatation of the heart and loss of weight. The relative safety of ligation as compared with thyroidectomy may lead the operator to accept as surgical risks patients so far advanced in the disease as to have but little prospect of cure. The gain in these cases is almost marvelous. Increase in weight averages about 22 pounds in four months with great improvement in the nervous and vascular systems. Thyroidectomy is advised at that time as severe cases may relapse at a later period; some, however, remain improved after many years. Should the condition recur before a partial thyroidectomy is made or should a severe relapse occur after partial extirpation, the inferior thyroid artery should be ligated or more gland removed, or both.

Anæsthetic.—The anæsthetic of choice is ether, as for other general surgical operations. It acts well in simple goiters and also in the majority of cases of hyperthyroidism. By reason of complications, disease of the kidneys, heart, or lungs, tracheal pressure or high blood pressure, a local anæsthetic may be indicated. In some cases it is advisable to secure the benefits of combined anæsthesia, following the general plan of Crile,[35] by the injection of 0.5 per cent. novocain with adrenalin followed by a light general anæsthetic. Novocain is about one-eighth as toxic as cocaine and is used freely in the line of proposed incision, also in the areas of nerve distribution. In using ether it is advisable to give the patient 1/120 gr. of atropin and a small quantity of morphin one-half hour before the operation. The atropin keeps the pharynx and trachea dry. In very severe cases of hyperthyroidism the giving of 1/200 gr. of scopolamin with 1/8 gr. of morphin one hour before operation does much to quiet the apprehensiveness of the individual. Some individuals have an idiosyncrasy for scopolamin which may be evidenced by pallor, delirium, etc., soon after administration. In such cases the drug should be discontinued and the operation postponed for 24 hours.

Operation.—In ligating the blood supply of the gland the vessels of the superior group are chosen because of their accessibility. The inferior thyroid vessels are usually ligated in cases where a serious relapse occurs between the ligation of the superior vessels and the proposed thyroidectomy. The transverse incision across the center of the thyroid cartilage is employed for ligation of the superior vessels,

as here there is freedom from the possibility of nerve-injury. The anterior border of the sterno-mastoid muscle is exposed and drawn outward, clearing the outer edge of the omo-hyoid, which is drawn inward. This brings into view the upper pole of the thyroid. The ligature is placed at the pole or slightly on the gland and includes sympathetic nerves, arteries and veins. This prevents the reversal of circulation in one of the large branches of anastomosis with the inferior which occurs when the vessel is ligated higher up. One or both sides are ligated at the same time, according to the conditions and the necessities of the case. In the more serious cases, the vessels of the left upper pole are ligated and if a severe reaction follows, the right upper vessels are ligated from five to seven days later. If the reaction is not marked, the right lobe, isthmus and inner border of the left lobe (about three-fifths of the gland) are removed at the second operation. When it is necessary to ligate the inferior thyroid artery, it is exposed by a transverse incision with a natural curve, then separating between the lower division of the sterno-mastoid muscle, the omohyoid is drawn to the outer side, the gland is exposed and elevated. In other words, the thyroid artery is located by palpation, exposed and ligated.

OPERATIONS ON THE THYROID

Ligation of the Inferior Thyroid Artery.—DeQuervain recommends that the inferior thyroid artery be tied external to the fibrous capsule of the gland. Through Kocher's collar incision expose the inner margin of the sterno-mastoid and retract it gently outward. Make a vertical 1-in. incision through the external fascia of the sternohyoid and retract this fascia outward with the sterno-mastoid. It is now easy to penetrate the loose connective tissue until the carotid packet is reached. Palpate the carotid tubercle on the transverse process of the sixth cervical vertebra; about 3/8 in. below this, one can feel the inferior thyroid artery immediately to the inner side of the carotid packet. DeQuervain ties the inferior artery as one of the first steps in almost any operation for goiter.

Thyroidectomy.—In severe cases of hyperthyroidism, in acute attacks and in relapses or exacerbations, the condition should be considered medical until improvement takes place. In case of relapse after a primary right thyroidectomy, the left upper pole is ligated; this operation is followed by removal of one-half of the remaining lobe after improvement occurs. The majority of patients having exoph-

thalmic goiter may be operated on when they come to the surgeon by the removal of one lobe and the isthmus, approximating three-fifths of the gland. The exophthalmic goiter case with unilateral thyroid enlargement is a safe one for the extirpation of the offending lobe. One of the great dangers of the operation is from myocardial change

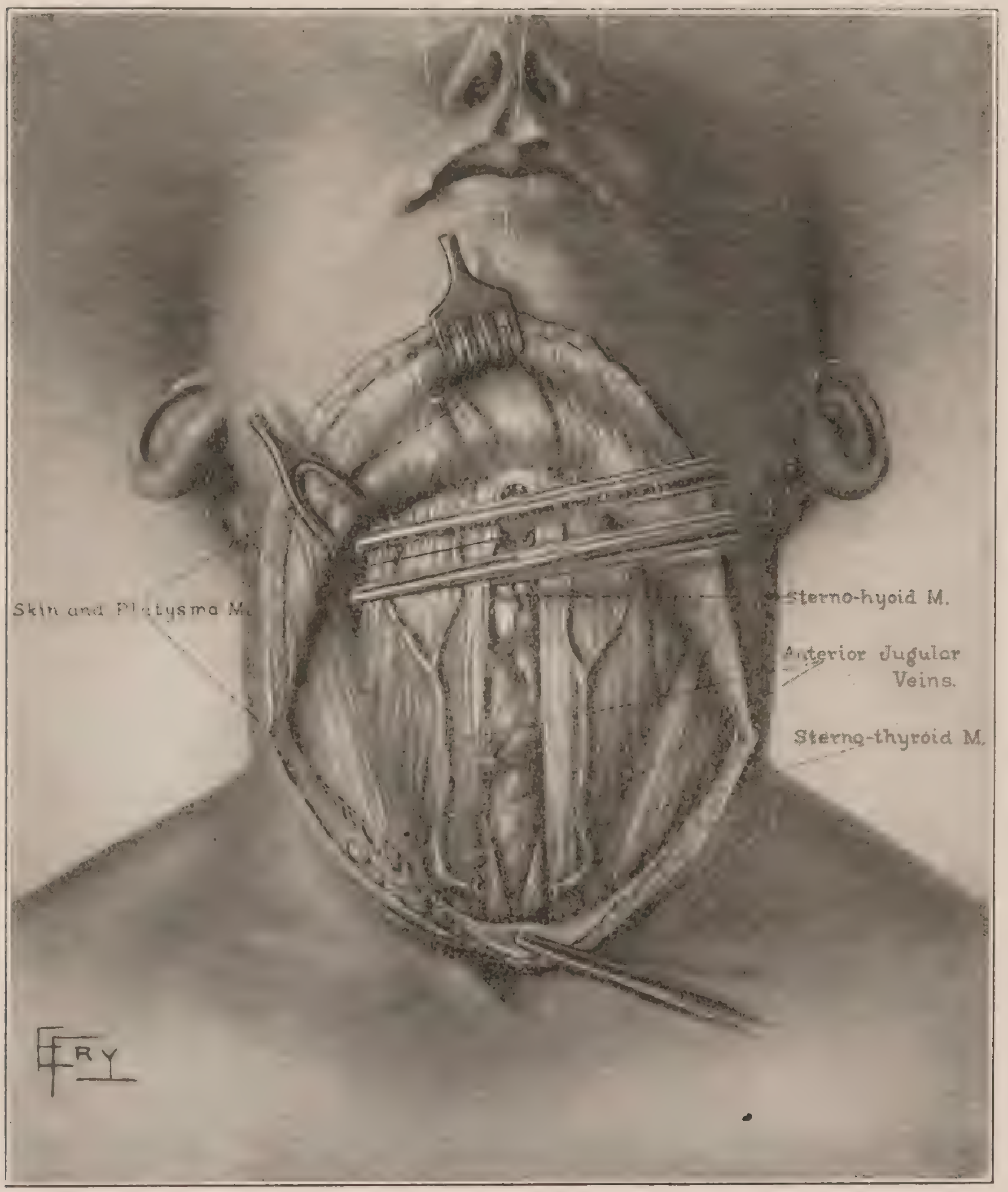

FIG. 271.—Exposure of anterior muscles, cutting of sterno-hyoid.

usually shown by uneven tension and irregularity in the pulse. No patient should be operated on radically whose pulse cannot be counted continuously because of uneven tension. Gastric crisis or diarrhœa should also lead to postponement of operation. Ascites and œdema of feet and hands are contraindications, and such cases should be

placed under medical care for a time. In most instances all the foregoing contraindications may be overcome.

Extirpation of the gland or resection is made by a transverse incision, passing from one external jugular vein to the other in a natural skin-crease low in the neck. The skin and platysma muscle are lifted up-

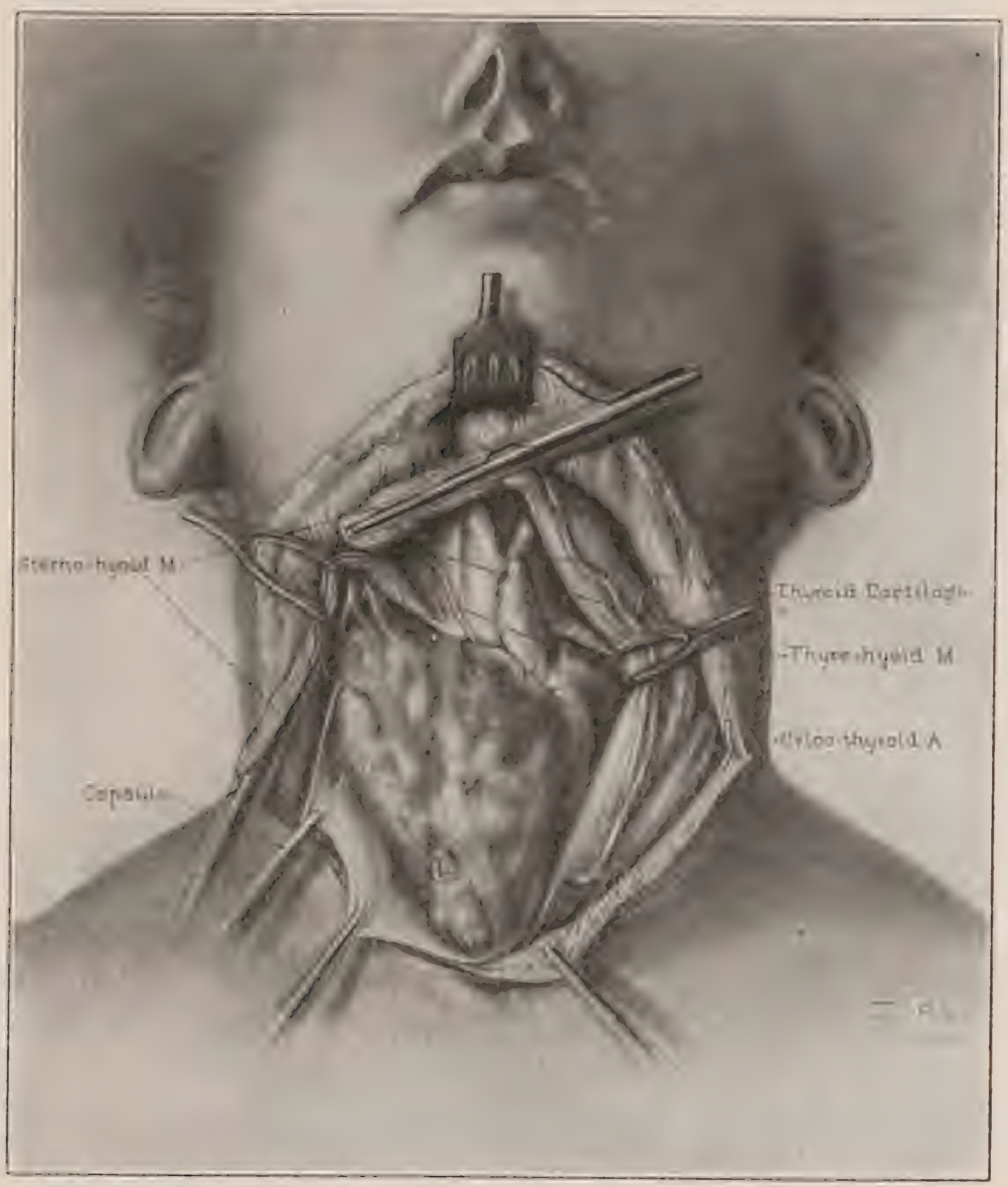

FIG. 272.—Opening lateral thyroid fibrous capsule.

ward as a single flap, exposing the general outline of the gland, which is now brought into view by dividing vertically between the sternohyoid and thyroid muscles (Fig. 271). The true capsule of the gland is recognized as the one containing the blood-vessels; false or fibrous capsules do not have them (Fig. 272). Usually the lobe to be removed can be elevated between these muscles as they are stretched, but in large goiters and in

exophthalmic goiters, it often becomes necessary to cut the muscles on one side, rarely on both. The muscles should be cut between two forceps which are placed near their upper ends, as this preserves the body of the muscle with its nerve-supply and breaks the line of penetrating muscle-moved scar so disfiguring after some operations. The lobe to

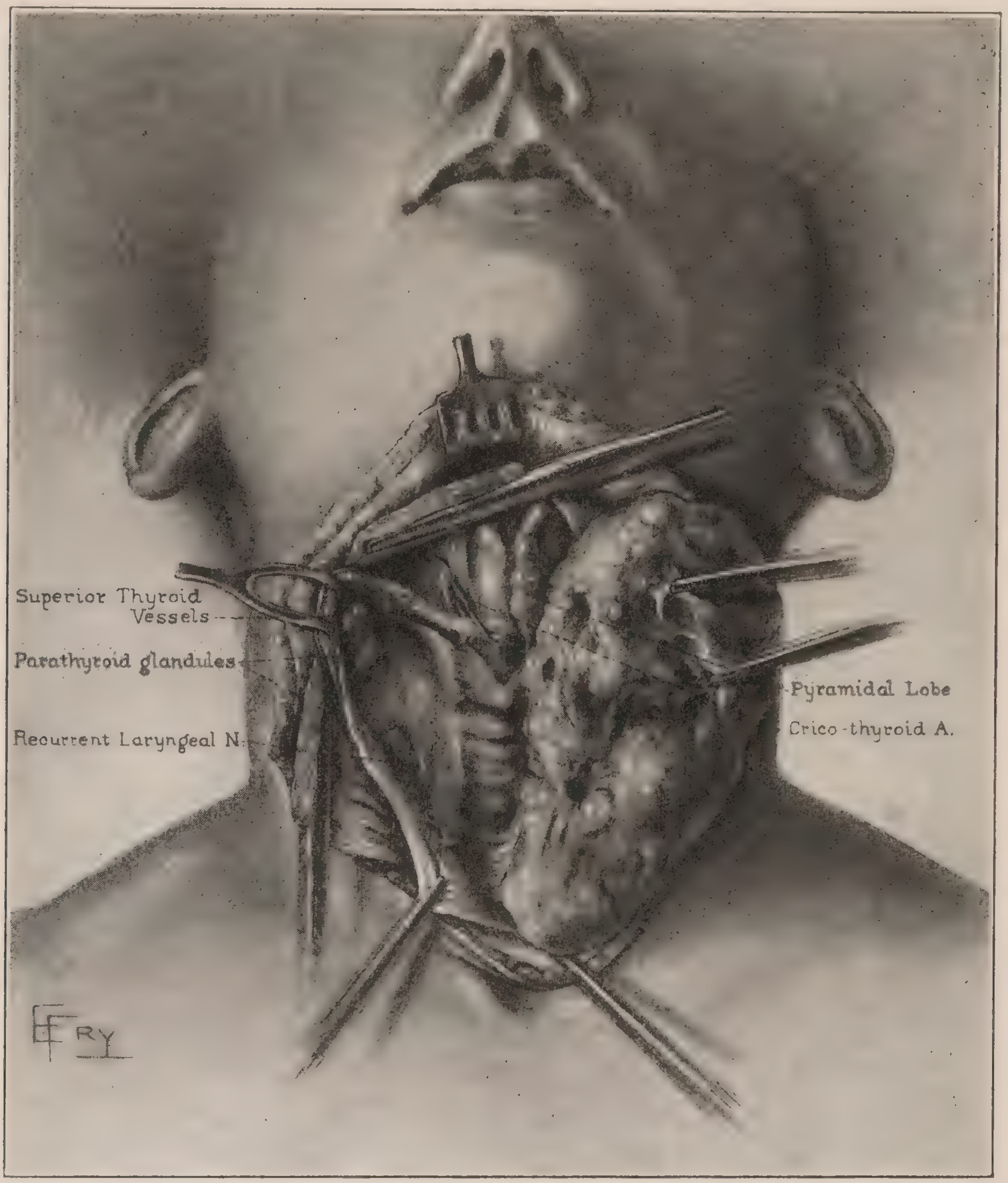

FIG. 273.—Elevation of thyroid gland.

be removed is now elevated and its vessels caught and cut between artery forceps, many being applied. The forceps are so applied as to skim the lateral and posterior surface of the capsule of the gland, securing as much capsule and as little of the surface of the gland as possible (Fig. 273). This method seems preferable to the immediate application of double ligatures unless the number of forceps which it is necessary to

use becomes a hindrance. The high division of muscle gives ready access to the superior thyroid artery which, after being divided, permits the rotation of the lobe across the trachea, where it is usually separated

FIG. 274.—Suture of muscles, drainage and closure of flap.

at the merging of the isthmus into the left lobe unless removal of part of that lobe is desirable. In very large goiters causing tracheal pressure it is often advisable to divide the left sternohyoids as well as to free the tracnea by dividing the isthmus of the gland, the central portion of the

thyroid being removed by turning the lobes outward. This operation is somewhat more bloody, but quite safe, as the trachea is exposed early. Catgut is efficient suture material. Silk is best when many ligatures are required, since they are rapidly encapsulated (Fig. 274). A few cases of adenoma can be closed without drainage after filling the cavity with salt solution.

In most cases, tubular drainage is employed for 24 hours, except in large substernal goiters, when the drain is removed within a few hours in order that the organization of the early blood-clot may occur to aid the primary closure of the large cavity. Fortunately the majority of large substernal goiters are of the encapsulated adenoma type and permit of enucleation within the thin fibrous investment.

To prevent tetany, the epithelial or parathyroid glands must be avoided in the course of an operation and preserved even if it be necessary to replace accidentally separated ones beneath the capsule of the thyroid at the pole of the gland. Such areas must be free from bleeding to insure growth of the graft. These bodies, four in number (two on each side), are known to be occasionally injured by hemorrhages into them at birth, so it is impossible to say whether or not the parathyroid bodies are all present and whether or not the one or two that we may injure are the only ones existing. It is advisable, therefore, to keep in front of the posterior capsule or very close to it in extirpating the diseased portion of the thyroid and not to remove any small gland-like structures, especially in those cases in which both lobes are operated on. Those surgeons whose patients have had tetany following operations for goiter have apparently removed the lateral lobes of the thyroid and left an isolated bit of the isthmus without blood supply or venous return. Even if the parathyroids were not removed their circulation was impaired. In such cases there has been both thyroid and parathyroid deficiency. The cases reported have usually recovered after a tedious convalescence and in spite of much experimentation.

The association of a diseased and especially an enlarged thymus with the goiter in cases of hyperthyroidism is claimed by some. In our experience, it is not a constant finding, yet a large thymus causing tracheal pressure may seriously complicate the operation of thyroidectomy.

In the early development of surgery, operations on exophthalmic goiters were delayed until serious complications arose in the heart, kidneys or nervous system. This led to a high mortality, which naturally deterred physicians from sending patients to surgeons for early

operation. The greater the delay the greater the mortality—hence a surgical vicious circle. The average mortality of operations on advanced cases was 25 per cent. The mortality at present varies from 1 to 3 per cent. This great reduction in mortality is probably due less to operative skill and technique than to better judgment as to the time and extent of the operative procedure instituted, as well as to the skilled use and rational choice of an anæsthetic. The various causes of mortality are hyperthyroidism, embolism, pneumonia, hemorrhage, sepsis, etc. About 75 per cent. of cases of hyperthyroidism are cured of such

FIG. 275.—Toxic-non-exophthalmic goiter. Clinical Group 1.

symptoms as are preventive of good health. All who survive are improved, many have permanent changes in heart, kidneys and vessels secondary to the toxæmia from hyperplasia or degeneration of goiter. Some degree of relapse occurs in about 10 per cent. of cases. In about 5 per cent. of these it is advisable to remove more gland.

Patients with severe exophthalmos when operated on late may still have this, as about the only symptom remaining after operation on the gland. In some cases we have reduced this prominence by removing the superior and middle cervical sympathetic ganglia on one or both

sides of the neck, the old operation of Jaboulay[36] and Jonnesco[37] for the relief of exophthalmic goiter.

TOXIC-NON-EXOPHTHALMIC GOITERS

Symptoms.—Plummer[25] divides the intoxications from non-hyperplastic goiter into two merging groups: (1) a group in which the cardiac toxin predominates, in which the clinical picture closely resembles and in many instances cannot be differentiated from the cardiovascular complex resulting from alcoholic, luetic, septic, and other well-known toxins (Fig. 275); (2) a group more closely approaching the picture of

FIG. 276.—Toxic non-exophthalmic goiter. Clinical group 2.

Graves' disease and including the cases that have been erroneously so diagnosticated by the mass of the profession (Fig. 276).

"Patients coming under observation with non-hyperplastic-toxic goiter give a history of having first noted the goiter at the average age of 22 years, and the evidence of intoxication at the average age of 36.5 years. The correponding ages for hyperplastic goiter are respectively 32 and 32.9 years."

"The average lapse of time between the appearance of non-hyperplastic goiter and toxic symptoms is 14.5 years. That the patient comes under observation three years later indicates that the onset is usually

insidious. Nervousness, tremor, loss of strength and weight, as a rule, develop slowly, but may appear suddenly long before definite evidence of myocardial damage. The administration of iodine may cause the sudden appearance of those symptoms with myocardial insufficiency much as they might follow the prolonged drinking bout of an old toper who had not previously shown decided evidence of chronic alcoholism. In some cases the clinical aspect, as noted above, closely approaches that of exophthalmic goiter. However, the symptoms are less complex, less definitely associated, and except for a damaged heart, less intense. There is much evidence to suggest that during the 14.5 years previous

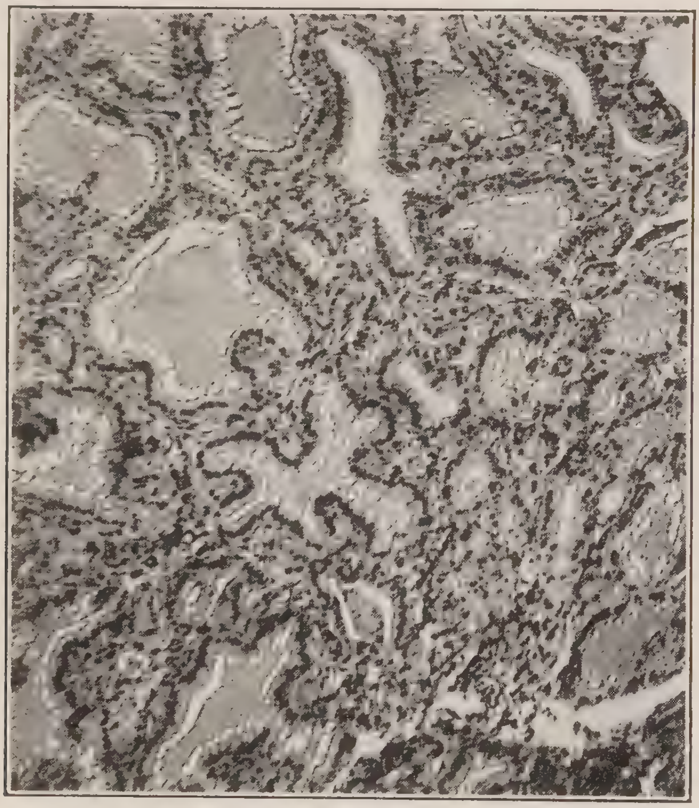

FIG. 277.—Photomicrograph of section of thyroid × 120 diam. Type C. Regressing primary parenchymatous hypertrophy and hyperplasia. From cases of clinical exoph thalmic goiter, late stage.

to the onset of definite symptoms many of the cases of non-hyperplastic thyroid may be compared to the alcoholic tippler in that if the soil is right they develop arteriosclerosis, and in many cases we have the combined picture of thyrotoxicosis and arteriosclerosis."

Pathology.—Wilson[38] has recently described the pathology of the thyroid in cases of toxic-non-exophthalmic goiter as follows: "The pathology of toxic-non-exophthalmic goiter of Plummer's clinical group 2 (*i.e.*, those resembling exophthalmic goiter) is one of increased parenchyma through regenerative processes in atrophic parenchyma (Fig. 277) or the formation of new parenchyma of the fœtal type (Fig. 278) with

an increase in each instance of secretory activity and of absorption. The process is a chronic one but sufficiently active to cause the patient to consult a surgeon earlier than do those cases in clinical group 1."

"The nearer the cases of clinical group 2 (toxic-non-exophthalmics) approach, in age and symptoms, true exophthalmic goiter, the shorter the duration of the period of goiter before operation and the smaller the average weight of the gland at the time of its removal."

"The cases of toxic goiter of clinical group 1 (*i.e.*, those in which the symptoms are of the cardiovascular variety) much more closely resemble cases of simple goiter in their pathology in all respects than do the

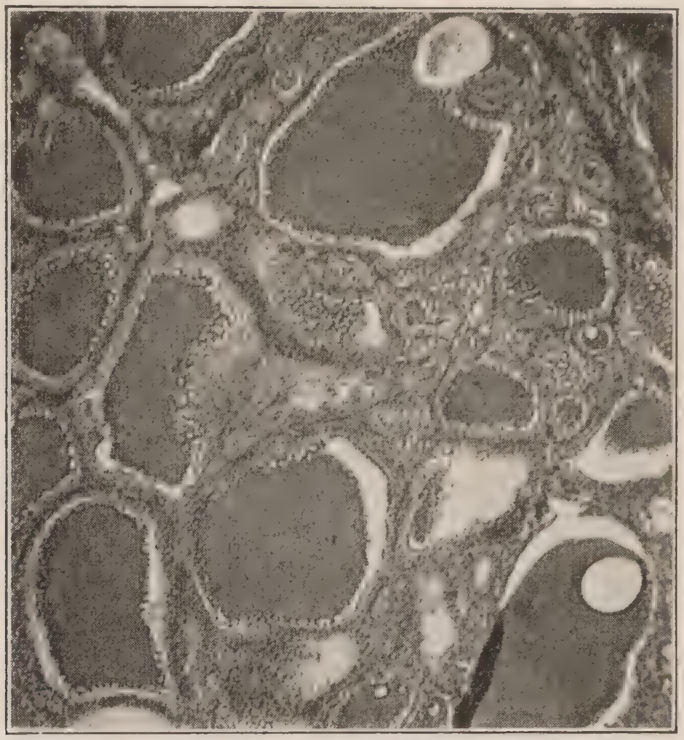

FIG. 278.—Photomicrograph of section of thyroid × 120 diam. Type D. Secondary regeneration of atrophic parenchyma. From case of clinical toxic-non-exophthalmic goiter.

cases of clinical group 2. A larger number of them are of the colloid goiter type, the enlargement of the thyroid has existed for a longer period before operation and the portion of the gland removed is materially larger than in those cases of clinical group 2."

"Finally, it may be stated that all the above pathologic evidence points to a constant relative association of increased secretion and increased absorption from the thyroid proportional to the degree of toxicity on the part of the patient. We have as yet no absolute proof that such secretion and absorption is the cause of, rather than coördinate with, the symptoms, but the presented evidence strongly points to that conclusion."

Treatment.—The treatment of toxic-non-exophthalmic goiter is, in the mild or early stages, practically the same as that of simple goiter. In its severe or advanced stages, the mortality is as high or even higher than that of exophthalmic goiter of similar severity and stage of symptoms.

NON-TOXIC GOITER

Until Plummer's[25] differentiation, the term "simple goiter" (Fig. 281) included a large percentage of cases without toxic symptoms, and a

FIG. 279.

small percentage with toxic (but non-exophthalmic) symptoms. There is no doubt that the term "simple goiter" should be dropped and the term "non-toxic" substituted as covering the majority of the cases, while those cases which present any toxic symptoms should be described as "toxic-non-exophthalmic."

To a variable degree thyroid enlargement may be due to demands made upon its secretion by certain systemic conditions, such as sexual development at puberty, the goiter of adolescence, the enlargement or hyperæmia at menstruation, also that during the latter part of

pregnancy, the changes at the menopause, and last but not least the possible iodine demand occasioned by bacterial infection of various organs, especially severe tonsillitis.

The simple enlargement of the thyroid in girls at puberty, is a fairly normal condition and indicates that menstruation is becoming established. It very rarely occurs that colloid or diffuse adenomatous goiter in the young becomes so resistant to treatment or so annoying in pres-

Fig. 280.

sure symptoms that extirpation or resection of a portion of a gland is necessary, although at times it may be advisable. Occasionally during this period, however, an encapsulated adenoma may develop into a rounded tumor occupying some part of the gland. It is best to remove such tumors.

While a large number of non-toxic goiters begin at puberty, especially in the female, many others take their origin after this period, the average age of onset of thyroid enlargement in patients coming to the

Mayo Clinic being 22 years. These cases have in many instances an endemic origin. Accumulated evidence shows that endemic goiter is frequently due to a water-borne irritant. In such cases, chronic intestinal toxæmia may occasion the extra demand upon the gland. For a thorough recent discussion of this most interesting phase of the subject, the reader is referred to McGarrison's[39] excellent work on the Etiology of Endemic Goiter. In America, sporadic cases are apparently more numerous than those in which an endemic relationship can be traced.

FIG. 281.

FIGS. 279, 280, 281.—Clinical diagnosis: atoxic (simple) goiter, Pathologic diagnosis: diffuse colloid goiter with atrophied parenchyma. Group H.

The symptoms are wholly those of pressure on the adjacent parts, except in those cases in which atrophy of the parenchyma has progressed so far that secondary symptoms of myxœdema have supervened.

Pathology.—Wilson[40] has shown in a report on 2356 thyroids from patients with non-toxic goiter operated on in the Mayo Clinic, that only a small fraction of 1 per cent. showed any degree of hypertrophy and hyperplasia of the parenchyma, 9 per cent. showed secondary regeneration of atrophic parenchyma, 23 per cent. were fœtal adenomas and 67 per cent. were adult adenomas, colloid goiters or diffuse adeno-

matoses (Figs. 279 and 280). The most striking point about the pathology in these non-toxic cases is the relatively small number of them which show even a fair amount of apparently active parenchyma. The bulk of the gland in almost every instance consists of dense colloid secretion or of degenerated fibrous or hyalin material.

Operations.—The operative procedure for the uncomplicated non-toxic thyroid is approximately the same as that for the simpler types of exophthalmic goiter; section of the muscles, however, is not often required. Operations on adenomas, colloid thyroids or diffuse adenomatoses as a rule involve but slight risk to the life of the individual. Many patients who are so afflicted wish to be relieved of the deformity, tracheal pressure, hoarseness or possibly of a severe neuralgia. Despite the enormous discomfort and suffering with which the disease may be accompanied, actual death therefrom occurs but rarely and then only from intrathoracic or from malignant or degenerative change in the gland. The occasional large goiter observed in the cretin has little or no active parenchyma. If these goiters cause distress, they should be removed. Changes in the voice are often caused by the presence of a non-toxic goiter. Matthews,[41] in the examination of 1000 cases, has shown that large, right-sided goiters quite frequently produce paresis of the left, recurrent, laryngeal nerve. It is, therefore, advisable to make a laryngoscopic examination before doing a thyroidectomy which otherwise may be blamed for the paresis discovered later. Loss of voice through injury of the recurrent laryngeal nerve during operation is not a rare occurrence. Possibly 10 per cent. of patients have some temporary hoarseness and about 5 per cent. a permanent difficulty with one cord, but rarely with loss of voice. These usually occur among those who already had some paresis or paralysis due to the pressure of a goiter. The left recurrent nerve, which is more frequently affected, lies slightly deeper than the right and has received more stretching during embryonic life. This may account in some measure for its greater susceptibility to injury from pressure. Extensive exposure of the nerve, as is done in some clinics, is necessary only in an operator's early experience, or in operating upon complicated nodular thyroids which extend beneath the trachea and which may have displaced the nerve. The scar tissue resulting from the traumatism of a too free exposure of a nerve may itself lead to secondary paresis.

In a series of 100 consecutive cases in other than goiter patients, or patients coming for examination on account of laryngeal symptoms, there were found one case of total paralysis of the left cord without

noticeable symptoms, one case of partial and one of complete abductor paralysis, and two of partial loss of both motions of the left cord. In one case only, the right cord showed a deficiency of both motions. These patients were more than normally liable to affections of the cords, since most of them came for other pathologic conditions in the nose and throat. But, since goiter patients are also especially affected by diseases of the nose and throat, it might be considered proper to deduct from the percentage due to goiter the 6 per cent. found in these cases. This would, in cases of slight enlargement of the thyroid, make the percentage for the right and left cord nearly equal, while in cases of greater enlargement the left cord would still show a relatively greater tendency to paralysis from pressure, probably on account of the great stretching this nerve receives in its embryonic development.

Intrathoracic goiters and deep substernal goiters are of serious import and are found about once in 40 operations for simple goiter. Slight substernal projections are much more frequent. The diagnosis rests on (1) dull area on percussion, (2) the Röntgenogram, and (3) evidences of substernal pressure (dilated veins, obstructive dyspnea and palpation of the upper pole of the gland just above the clavicle). Probably one-sixth of the original gland-cells are competent to furnish all secretion necessary. It is best to preserve this much or more of the gland until there is more evidence furnished that all of the gland can be removed with no ill effect as is claimed by some surgeons in their treatment of exophthalmic goiter.

As regards the non-surgical treatment of goiter, there is no question but that many cases of simple goiter, especially of the adolescent type, undergo a natural resolution, which is also true of those congestions and enlargements occasionally observed during pregnancy. In the hyperæmic goiters of adolescence some form of iodine treatment may have a favorable effect. In encapsulated adenomas the use of iodine may manifest a temporary favorable effect on the surrounding gland, but its effect on the encapsulated tissue is uncertain. Its use on goiters of long-standing in patients between the ages of 35 and 60 seems to stimulate the activity of the thyroid and to cause degenerative changes. Considering specific intestinal toxemia as a causative factor, the more recent experience of McGarrison[39] in the non-surgical treatment seems to indicate the use of thymol, salol and iodin as intestinal antiseptics. The administration of thyroid has rather an uncertain effect, yet apparently produces favorable results in the early treatment of simple goiters.

In operating on the thyroid, the gland is best exposed through a transverse incision made low down in the neck, the skin and platysma being reflected upward and downward from the incision. If further exposure is required the sternohyoid may be divided high up in the exposed area. High division of the muscle preserves the nerve supply intact and later prevents adhesion between the line of union of the sutured muscle and that of the skin. Adhesion between the scar in the muscle and that in the skin makes the latter move with the muscle in an uncomely fashion. If one lobe of the gland is much more enlarged than its fellow that large lobe should be extirpated. If both lobes are

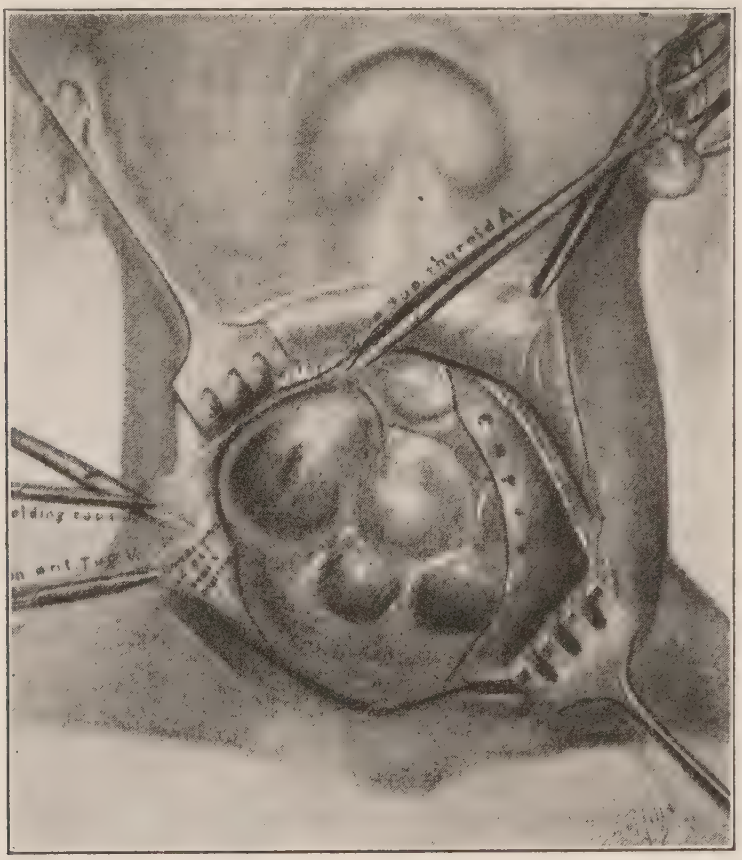

FIG. 282.—Enucleation of cystic goiter. Capsule opened.

symmetrically enlarged, division of the isthmus and resection of portions of both lobes are indicated and give the best cosmetic results. Adenomas encapsulated in the middle line should be enucleated and the isthmus divided (Fig. 282). Adenomas encapsulated in the lateral lobes may be enucleated or the whole affected lobe may be extirpated.

The mortality from operations on goiters (other than malignant) is very low, no matter whether the disease is the so-called simple goiter (in which class there may be occasional complications) or exophthalmic with hyperplasia of the gland.

The results of operations on simple goiters are well known to be

exceedingly satisfactory. Severe myxœdema is but a rare complication following such operations, especially if the area of the gland nearest the capsule be preserved. The large colloid masses in the interior of these glands represent the bulk of the tumor but the least amount of the working area of thyroid tissue.

MALIGNANT TUMORS

Malignant tumors of the thyroid are not numerous. Less than 1 per cent. of the cases operated on in our Clinic show malignancy. This of course does not include those patients who come for examination and are considered inoperable. Both carcinoma and sarcoma occur, the former with much the more frequency. Carcinomas are usually of the alveolar type, and sarcomas of the spindle-celled type. Clinically, it is often impossible to differentiate the two. When a rapidly growing, non-inflammatory hard tumor appears in a patient of the cancer-bearing age its malignancy is strongly suggested. The diagnosis should, if possible, be made before the growth has penetrated its capsule and involved the neighboring structures, *e.g.*, the trachea and muscles.

Treatment.—The only treatment which affords any hope of relief is free removal of the whole of the thyroid tissue. Unfortunately, early glandular and lung metastases are common. In most cases, the growth has proceeded beyond its capsule before the patient comes to the surgeon and the ultimate results are not promising. When the tumor recurs, its progress is more rapid than before operation.

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SECTION XX

THE PARATHYROIDS

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The diminutive size of the parathyroids and the intimate topographic relationship between them and the thyroid make it intelligible why, for a long time, investigators failed to consider a functional independence of these little bodies. In 1880 a Swedish anatomist, Sandström, first described the parathyroids in man, also in various other species of animals. In the beginning, Sandström viewed these structures as arrested embryonic stages in the development of the thyroid. In 1891 Gley for the first time discussed the physiologic importance of the parathyroidal tissue. This investigator believed that after total thyroidectomy these glandules assumed the function of the thyroid. Many other investigators (Kocher, Reverdin, v. Eiselsberg, *et al.*) made the observation that, following total extirpation of the thyroid in various animals, in some cases the resultant condition was cachexia strumipriva, in others typical tetany. These dissimilar effects are explained in the light of anatomy, which shows the differences in the topography of the parathyroids in individual species of animal. Through the investigations of Pineles, Biedl, Erdheim, *et al.*, the independence of these little bodies has been established beyond doubt. Many maintain that the evidence today is sufficiently extensive and conclusive to prove that tetany following operation on the thyroid is not a tetania strumipriva, but a tetania parathyreo-priva. Divergent views still exist, however, with regard to the underlying pathology of the various other forms of tetany, but the observations of Jeandelize, Pineles, Escherich, Erdheim, Chvostek, Rudinger, Haberfeld, Geluke, MacCallum, *et al.*, strongly support the theory that all of these rest on a pathogenetically uniform basis, and that all are founded on an absolute or relative insufficiency of the parathyroids.

An etiologic rôle in several other diseases has been attributed to the parathyroids by some writers. Berkeley assumed a hypoparathyroidal genesis for paralysis agitans, basing his view on the ground of the favorable therapeutic effect of treatment with preparations of parathyroidal

tissue. This author reports 60 cases, almost 65 per cent. of which manifested a decided improvement from the administration of Beebe's parathyreo-nucleo-proteid. In four cases of paralysis agitans, Roussy and Clunet found the parathyroids enlarged and presenting, on histologic examination, simple hyperplasia with much colloid and a great number of oxyphilic cells. These authors viewed this finding as indicative of parathyroidal hyperfunction. Roussy and Clunet demonstrated a directly unfavorable influence on the disease of paralysis agitans from the employment of parathyroidal medication. In three cases of this same disease Erdheim found the parathyroids normal. Lundborg and Chvostek have ascribed myasthenia pseudo-paralytica to excessive function of the parathyroidal tissue. Chvostek views myasthenia and tetany as diseases which, in manifestations, are diametrically apposed. This is indicated in the electrical and other reactions. Evidences on the part of the muscular fibers rather point to myasthenia as belonging to the diseases of the muscular system. Haberfeld states that many cases are known, among which were hypertrophy and genuine tumors of the parathyroids, without the slightest manifestations of myasthenia.

Embryology.—The parathyroids arise from the dorsal part of the third and fourth branchial clefts. There are usually two on each side, but variations from this are not infrequent. The thymus arises from the ventral part of the third cleft. From this close association of the parathyroid and the thymus in the third cleft the parathyroid may remain applied to or even enclosed within the thymus. The parathyroid derived from the fourth pouch becomes later in development annexed to the thyroid, and can eventually be embraced by thyroidal tissue. Embryologic investigations up to the present support the view that the relation of the parathyroids to the thyroid is purely topographic (Falta).

Anatomy.—Various tissues in the vicinity of the thyroid may grossly simulate a parathyroid, namely, lymph nodes, hemolymph nodes, fat, accessory or aberrant thyroids and thymic rests (Figs. 283, 284 and 285). It has been stated that for differentiation and exclusion of these tissues, microscopic examination is absolutely essential. That this statement is true viewed in the light of limited experience in operations on the thyroid is not to be denied, but it is equally true that with sufficiently extensive anatomical experience of this region on the living, the parathyroids can usually be detected. Because of post-mortem changes, the differentiation is not so readily made grossly on the cadaver, but in this case also with increasing experience, the percentage of positive

diagnoses of the parathyroids is greatly raised. This has been proved by a comparison of results in the early with those in the late cases of an extensive anatomic series. In the former only 36 per cent. of suspected structures was parathyroidal; in the latter, about 90 per cent.

The number of parathyroids is usually stated as four, occurring in pairs—a superior and an inferior on each side. While, however, the

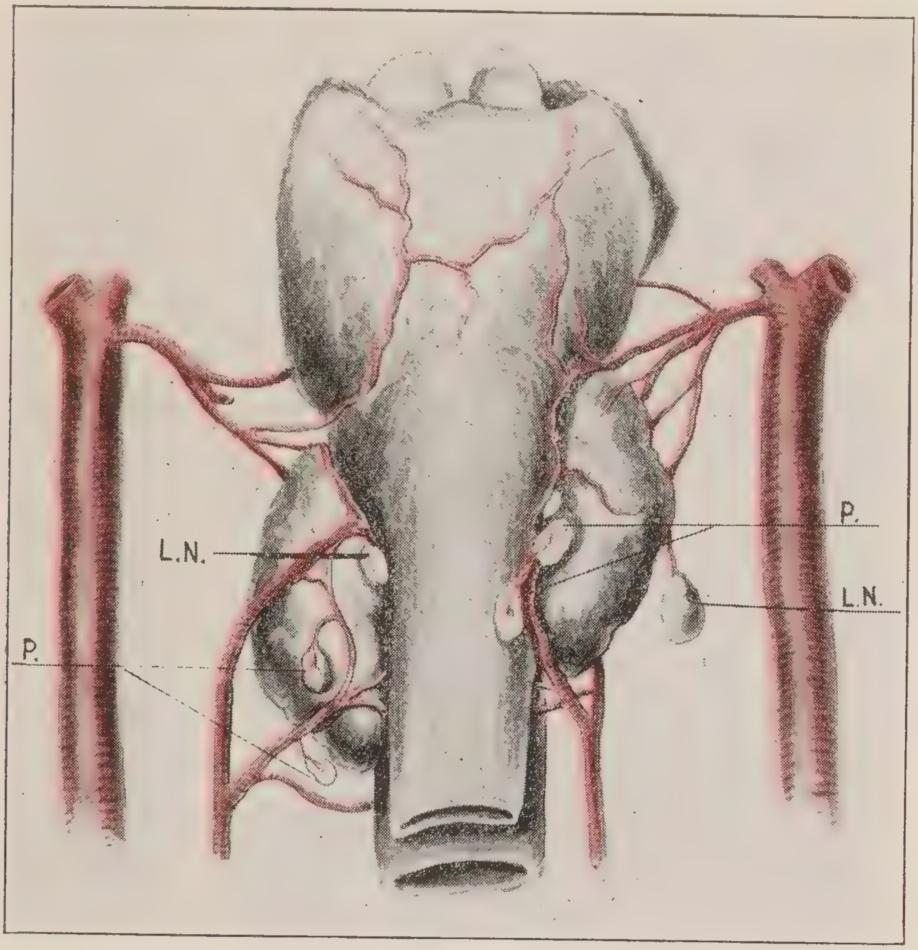


FIG. 283.—Posterior view of thyroid. P., Parathyroids; L.N., lymph nodes. (*Ginsburg Journ. A. M. A,. June*, 1912.)

studies of some have shown that the numerical constancy of these glandules is subject to slight variations, the investigations of others indicate that this number is often diminished by one or more, and occasionally increased. In 125 autopsies on the human, Berkeley found about an average of two and one-half parathyroids per person. In 138 autopsies by Verebely four parathyroids were found 108 times.

The location is not constant. Halstead and Evans found the higher of the two glandules of one side to be, on the average, about at the level of the upper and the middle thirds of the lateral lobes of the thyroid. The lower of the two parathyroids is usually not far from the lower pole, rarely as high as the middle of the thyroid lobe. Very regularly the little bodies are situated on or very near the posterior border of the

lateral lobe of the thyroid, and more or less in line with the "channel" of anastomosis—an important landmark—between the superior and the inferior thyroid arteries. Among the *variations* in location are, at or above the tip of the superior pole of the thyroid; on its outer surface; at or below the inferior pole, even within the bony thorax; on the anterior surface of the isthmus; and within the thyroid. Rogers and Ferguson cite a case in which a parathyroid was found in the middle of the posterior surface of the pharynx at the level of the lower border of

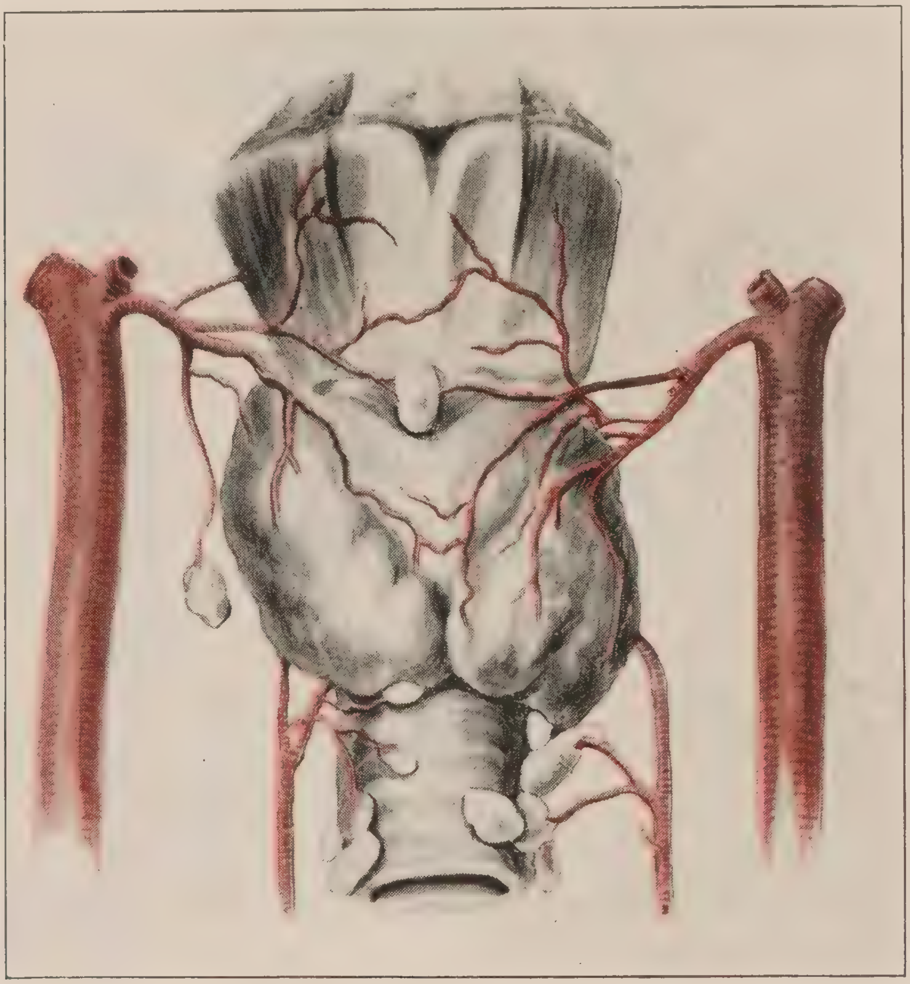


FIG. 284.—Ventral aspect of the thyroid gland. Note the large number of lymph-nodes, some having a separate arterial twig. There are no parathyroids in this drawing. (*Ginsburg, Journ. A. M. A.*)

the cricoid cartilage. The writer has found an accumulation of parathyroidal tissue in a cavity of the hyoid bone. A fistulous communication was present. *Accessory* and *aberrant* parathyroids are not infrequent. Small accumulations of parathyroidal cells are found variously located and explain many of the conflicting views as to the number and location of these structures, also the divergence in experimental results. In the light of recent research, it is clearly conceivable that in the form of this scattered parathyroidal tissue, after an assumed complete para-

thyroidectomy, sufficient functionating glandular substance may remain to defeat the object of the experiment. Such cellular accumulations have been described by Müller and Erdheim. Getzowa has found these metameric epithelial bodies frequently within the thyroid, and practically always intrathyroidal in the absence of the superior parathyroids. Similar sparse, isolated groups of parathyroidal cells

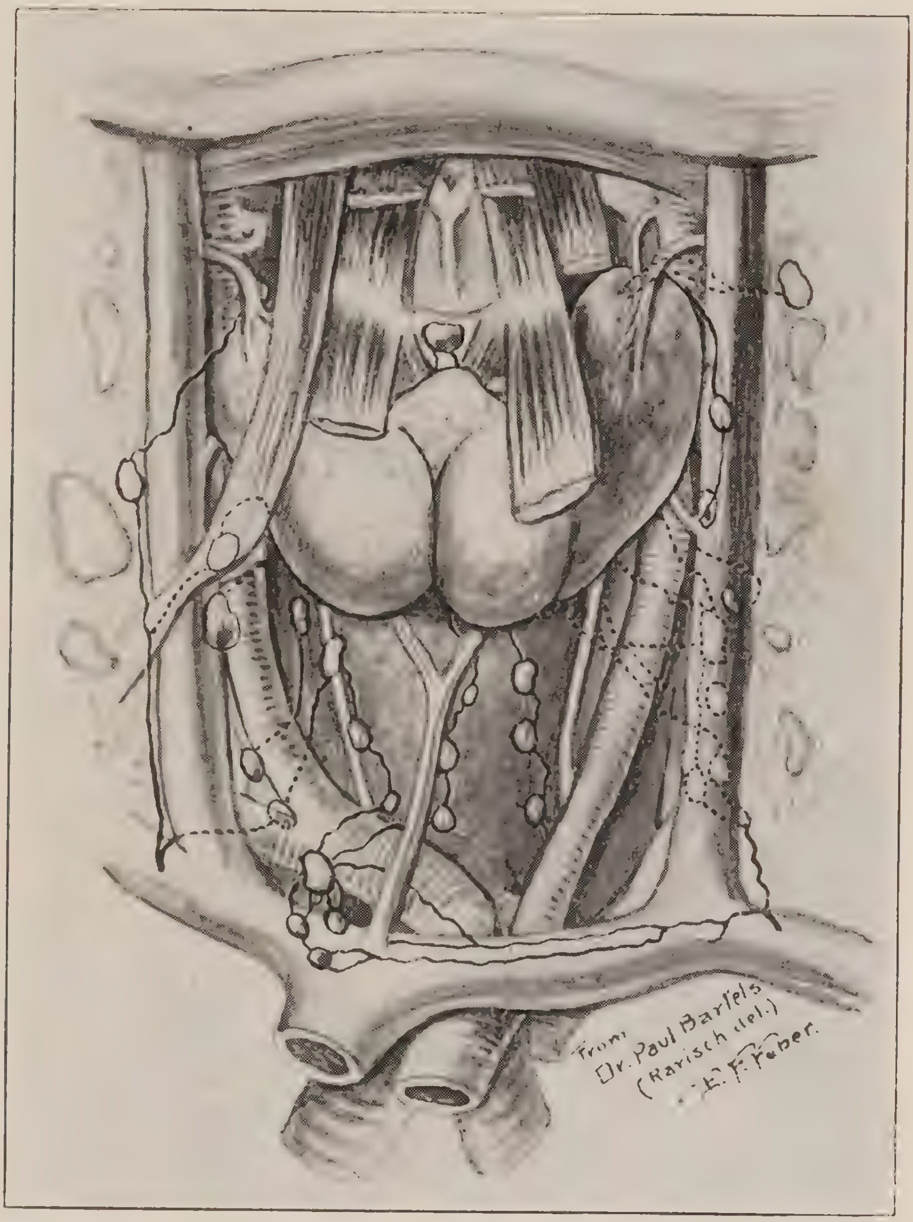


FIG. 285.—Ventral aspect thyroid gland. Note the lymph nodes in pretracheal region in close association with the thyroid gland. (*Ginsburg, Journ. A. M. A.*)

are also found in the presence of a superior thyroid, and these Getzowa designates as a third epithelial body of a rudimentary fifth branchial cleft. The intrathyroidal location of parathyroidal tissue is quite common in several quadrupeds, notably in the horse, dog and goat. The presence of nodules of thyroid, thymus and lymphatic nodes near the usual site of the parathyroids is frequently noted. In 263 specimens

selected as resembling parathyroids, 111 proved to be thyroid tissue in large part (Rogers and Ferguson). The same investigators found thymic remnants present in a considerable number, and these occurred

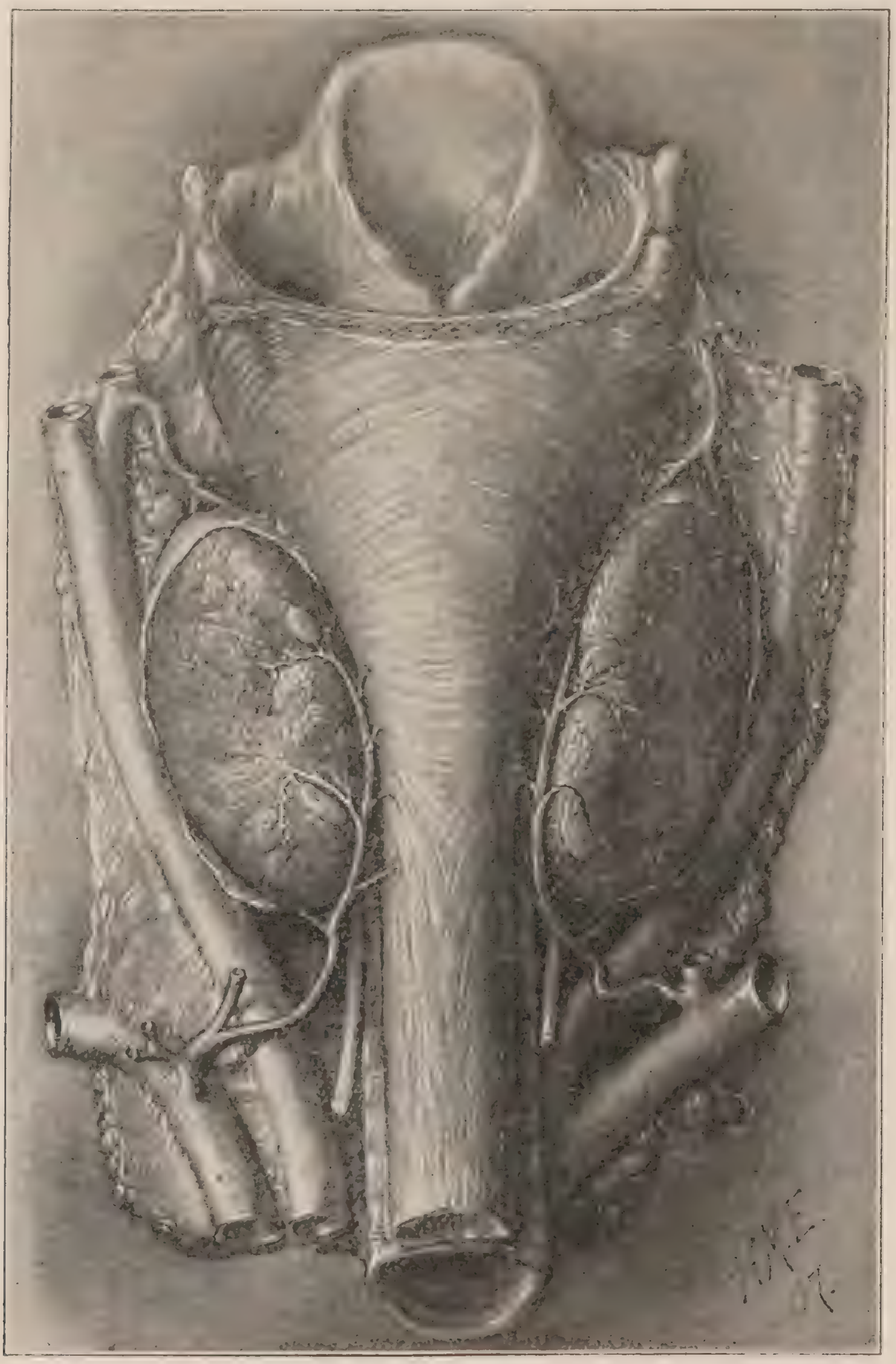


FIG. 286.—Parathyroid glandules. (*Halsted-Evans.*)

in the aged as well as in the young, but mostly in infants. Ginsburg emphasizes the difficulty in differentiating parathyroids from closely allied lymphatic nodes. These nodes are numerous in the region of the thyroid, and at times their size, relation and blood-supply so simulate those of the parathyroid that they can be differentiated only by histologic examination.

The parathyroids are described as flattened, ovoid or reniform bodies, each covered by a thin fibrous capsule, beneath which a fine anastomosis can be seen. The surface presents an exceedingly fine, barely visible, granular appearance, probably due to the blood-vessels (Halstead and Evans). The color is reddish, reddish yellow, or brownish red. The length varies from 3 to 15 mm.; the width or thickness is about 2 mm. In Halstead and Evans' excellent description of the vascular supply it is stated that, "each glandule has invariably its special artery which might be designated the superior and the inferior parathyroid artery—right and left (Fig. 286). The vessel is large in proportion to the organ supplied, and this aids in the body's identifi-

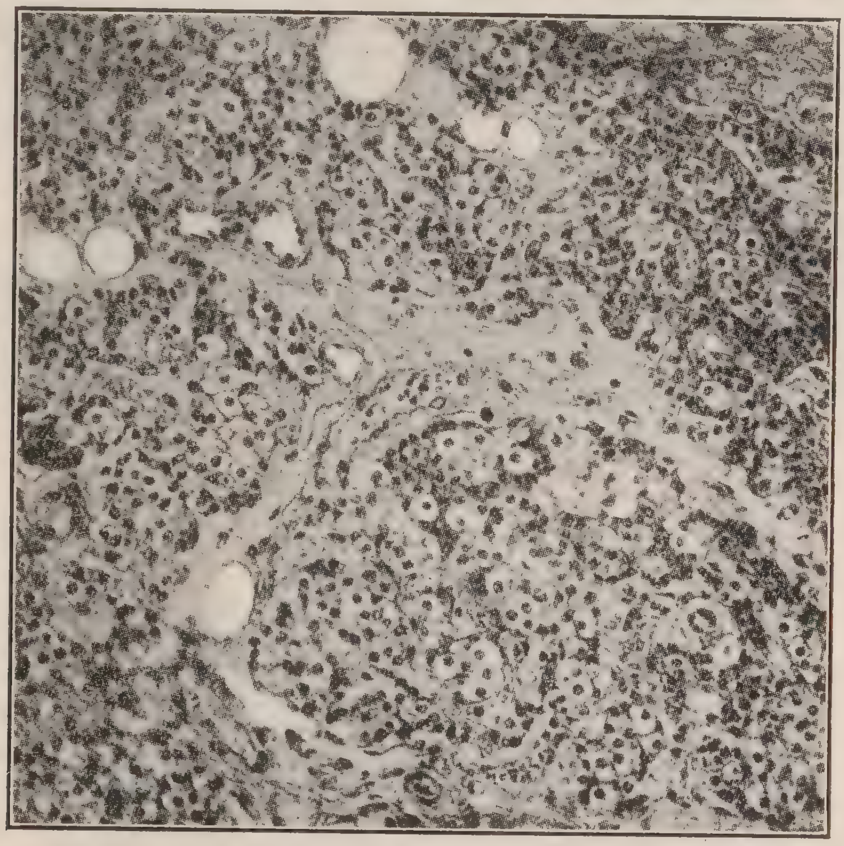


FIG. 287.—Principal cells. (*Pool.*)

cation. The glandules are quite free, and, as cherries on the stem, hang from the artery, which enters the hilus." Both parathyroidal arteries usually arise from the inferior thyroid, but frequently they take origin from the anastomosing channel between the inferior and superior thyroid vessels. Beside these usual sources, other types of origin are described. To be noted, however, is the simulating vascular plan of the neighboring lymphatic glands.

Histology.—The glandule is composed of a mass of cells enclosed by a thin fibrous capsule. Irregular processes project inward from the capsule. The main types of cells are the so-termed principal cells,

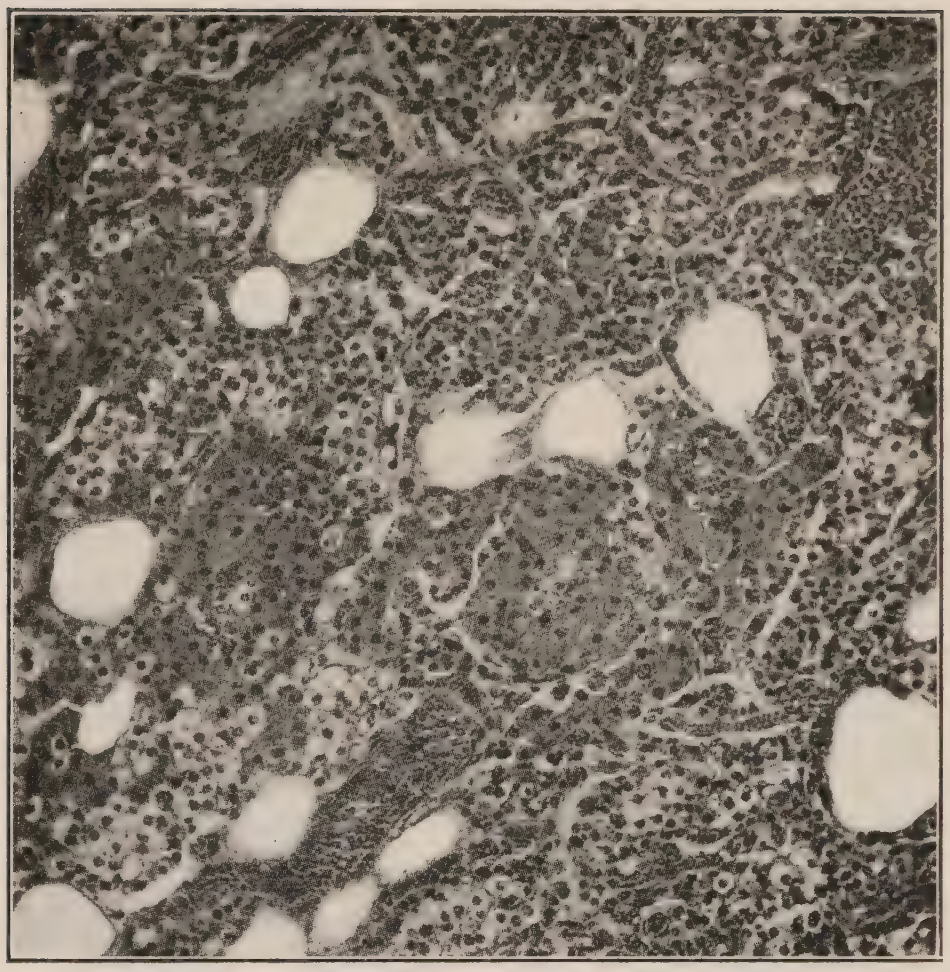


FIG. 288.—Masses of oxyphile cells. (*Pool.*)

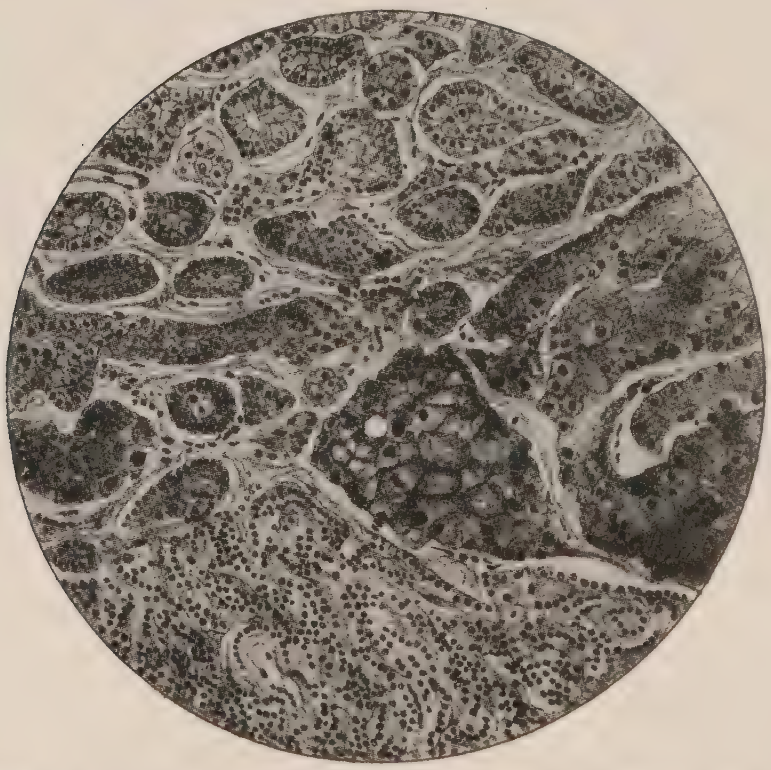


FIG. 289.—Diffuse hypertrophy of the parathyroid. To the right and below accumulations of oxyphilic cells; above, alveoli with small oxyphilic cells. To the left and below columns of principal cells.

eosinophiles and fat cells. The amount of fat is very variable, and is present both as a cellular metamorphosis and as an infiltration of the stroma. In later life fat may considerably predominate in the structure of the parathyroid. Welsh has classified the parathyroidal cells into two principal types: (1) the "principal cells," which greatly predominate (Fig. 287); (2) the "oxyphilic cells" (Figs. 288 and 289). The former apparently consist of only a nucleus and a membrane, which is decidedly eosinophilic, the cellular body, as a rule, not being pronounced. The nucleus is large and the chromatin network open. The oxyphilic cells have a relatively large body with fine, strongly eosinophilic granules. The nucleus is small, deeply staining, and with chromatin closely arranged. These cells are variously distributed. They are frequently noted as compact accumulations beneath the capsule, as anastomosing columns and singly or in small groups scattered among the principal cells. Many other cellular forms, intervening between the two main types, have been observed. These cells are not considered characteristic.

Physiology.—Viewed in the light of experimental results, clinical and surgical experiences the parathyroidal glandules appear to be structures of vital importance. However, the exact nature of the function of the parathyroidal tissue remains still in the dark. The summation of evidence reported by able investigators in physiological research indicates that in the assumed complex correlationship among the organs of internal secretion these glandules play an important rôle in the maintenance of physiological equilibrium.

Various combinations of investigations on animals of different species have uniformly established that from the removal of all four parathyroids—provided that no accessory parathyroidal structure is present—fatal tetany results. If two or three of the glandules be removed, the animal, as a rule, lives, but undergoes a transitory tetany. In the latter case, occasionally the tetanic attacks recur under certain conditions, for example, pregnancy and various intercurrent diseases. Such animals are, therefore, in a state of latent tetany. It is stated that the animal tends to withstand a loss of one-half its parathyroidal tissue without injury. Following removal of a part of the parathyroidal substance, the remaining portion undergoes hypertrophy, as noted by Halstead, Biedl, Haberfeld and Schilder, *et al.* This evidence of the importance of the parathyroids in the production of experimental tetany has been supplemented by observations on post-operative tetany in the human. Erdheim is credited as having been the first to accu-

rately demonstrate this condition following thyroidectomy in man. However, despite these convincing experimental and post-operative observations, there are some authors who do not accept the parathyreoprivous nature of tetany, being unwilling to admit such an important rôle for structures so insignificant. The apparent benefit from the administrations of the thyroid seem to lend support to this objection, but these results have not been sufficiently definite for a positive opinion.

Still less uniformly an agreement exists as to the parathyreoprivous nature of the remaining forms of tetany. Several investigators, notably Erdheim, Yanase, Habèrfeld, *et al.*, support the theory of intraparathyroidal hemorrhage in the case of infantile tetany. Such hemorrhages are assumed to occur during intrauterine life or at the time of labor, and to the occurrence of these hemorrhages are also attributed tetanic attacks of later childhood and even adult life. In such cases an hypoplastic condition of the parathyroids has been observed, and the only indication of the early bleeding may be the presence of hematogenous pigment, together with evidence of inhibited growth of functional tissue. The existing, limited parathyroidal material suffices to maintain a state of equilibrium in the presence of normal conditions, but with the advent of some intercurrent disturbance, such as the common gastrointestinal diseases of the young, infections, pregnancy, etc., the glandules become relatively insufficient for the increased demand. Beside the rôle of these little bodies, there is some other factor which precipitates the tetanic attack. The nature of this is unknown. The picture presented in parathyroidectomized animals is characteristic, and based, for the most part, on a state of hyperexcitability of the nerves, not the muscles. There is a latent period of about 40 hours, then from a gradual change in the excitability of the nervous system, the animal presents various convulsive manifestations, which lead to most intense spasms. The result may be death, or recovery with repetition of the attacks. There are also sensory, gastrointestinal and vasomotor disturbance, and an underlying cachexia. Voegtlin and MacCallum emphasize the significance of electrical excitability of the motor nerves, regarding it as a most characteristic criterion of the existence of tetany. This, these investigators say, affects all the measurements, but the variation from normal in the K. O. and A. O. seem to be far greater than that of K. C. and A. C. Five ma. are needed to produce the slightest contraction in the normal, but in tetany 1/10 ma. when passed through the nerve may suffice to cause a violent jerk.

MacCallum further states that apparently this same electrical hyperexcitability is present in the sensory, the vegetative and the sympathetic nerves, and is the underlying cause of all the symptoms, although itself is the effect of the change that follows the loss of the glands. Experimentation has proved that this state of the nerves is produced by some alteration in the circulating blood. Some ascribe the condition of the nervous system to a specific poison which arises, following the removal of the parathyroids. MacCallum suggests that it may be something which withdraws a moderating and quieting influence from the nerve cells and leaves them in an unbalanced and hyperexcitable condition. This assumed element causing a change in the blood in tetany precipitates or renders useless the calcium of the nerve cells. After parathyroidectomy, a solution of calcium salts intravenously injected or administered in large doses by mouth stops very promptly the tetanic symptoms, but the symptoms re-appear when the effect of the calcium is gone. Like strontium and magnesium, it is effective in tiding over the danger in case of emergency.

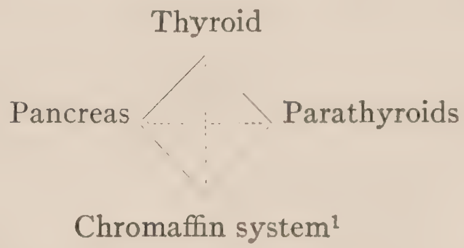
The manifestations of tetany in parathyroidectomized dogs have failed to appear or, when present, have ceased, at least temporarily, in case of operative procedures on the tibia or similar operations (Thompson and Leighton). Guleke observed in experiments on cats and dogs that tetanic attacks, following simultaneous extirpation of the parathyroids and thyroid, ceased on removal of the adrenals, and did not recur up to the time of the animal's death. Injections of adrenalin caused the spasms to reappear. In some of the experiments, ligation of the veins of the adrenals was substituted for extirpation of the adrenal glands. The result was cessation of the attacks, but recurrence after a time. At autopsy, the blood circulation was found completely reëstablished through anastomosis. Whenever, in these experiments, a small portion of thyroid was left in the animal, though the spasms ceased after removal of the adrenals, they recurred after a short latent period. The effect of the thyroid on the existence of tetany is similar to that of the adrenals, but not so pronounced. From this series of experiments it was concluded that, beside the antagonism between the parathyroids and the adrenals, there exists a similar antagonism between the parathyroids and the thyroid. Very likely the secretion of the thyroid gland excites the sympathetic similarly as the secretion of the adrenals, while the parathyroids hold both organs in equilibrium.

That the secretion of the thyroid has an exciting effect on the sympathetic is supported by the investigations of Kraus, Eppinger,

Kostlivy, *et al.* The relationship which Guleke has observed among the parathyroids, the thyroid and the adrenals is quite well confirmed by the literature.

A schema by Eppinger, Falta and Rudinger indicates their view of the correlationship existing among the pancreas, thyroid and adrenals (chromaffin system). These investigators maintain that the thyroid and the chromaffin system have a reciprocal advancing influence on each other, while the pancreas experiences a pronounced inhibition from both.

Convinced by his own observations and drawing support from the investigations of others, Guleke inserts the parathyroids into the schema of Eppinger, Falta and Rudinger. The following reproduction of Guleke's schema clearly explains this author's view. Assuming that future investigations will confirm the results of Guleke's experiments showing the important rôle of the adrenals in the tetany of thyroid—parathyroidectomized animals, a path seems indicated along which



much may be gathered for a more comprehensive view of this disease.

Pathology.—Pathologic conditions of the parathyroids which have been reported are hemorrhage, degenerative and progressive changes, cystic degeneration, retention cysts, amyloid infiltration, chronic fibrous parathyroiditis, syphilis, tuberculosis and tumors (Figs. 290 and 291.) Neoplasms are rare. v. Verebely classifies the tumors into two groups: (1) extrathyroidal; (2) intrathyroidal. Tumors have been reported by de Santi, MacCallum, Hulst, Da Costa, *et al.* Microscopic examination has been necessary to diagnose the tissue as parathyroidal. Only local symptoms have been noted. A few cases of tuberculosis of the parathyroid have been observed (Benjamins, Verebely, Eggers, Winternitz, *et al.*). Tetany associated with this condition has been reported. Verebely remarks that, like other organs, these glandules can be affected by poisons through the blood stream or from neighboring organs.

Clinical Symptoms.—The symptoms of tetany are manifold and the individual forms show the greatest variety in the location of the spasms. The "obstetrical hand" is a typical position. In children,

[1] The neighboring parts affect each other antagonistically; the opposite parts in an advancing manner.

especially, the fingers may be separated and only the terminal phalanges flexed. The feet may assume the position of equinus or equinovarus. Dyspnœic disturbances are frequently met. Laryngospasm is often a predominating symptom in children. The duration of attacks varies

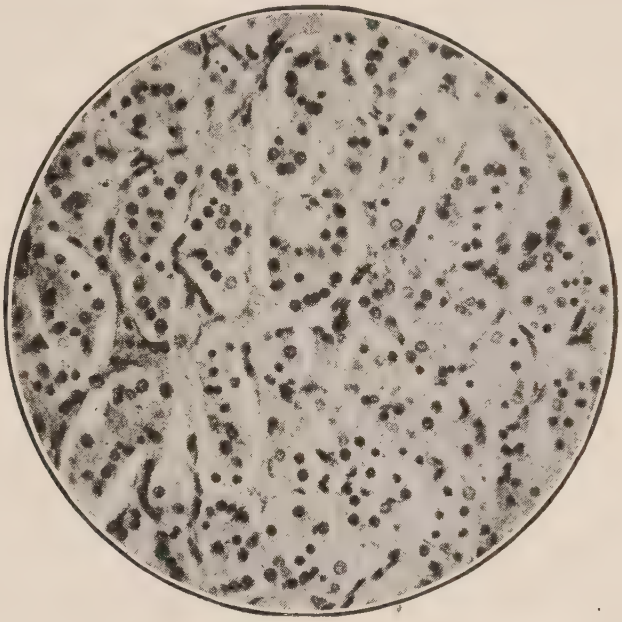


FIG. 290.—Photomicrograph of tumor nodule showing resemblance to parathyroid glandule structure. × 150. (*Thompson and Harris.*)

from a few minutes to several hours, the free interval from a few moments to days or weeks. The patient generally rests during the night. The sensorium is usally free in the adult, but in severe cases even complete loss of consciousness may be present. Besides the

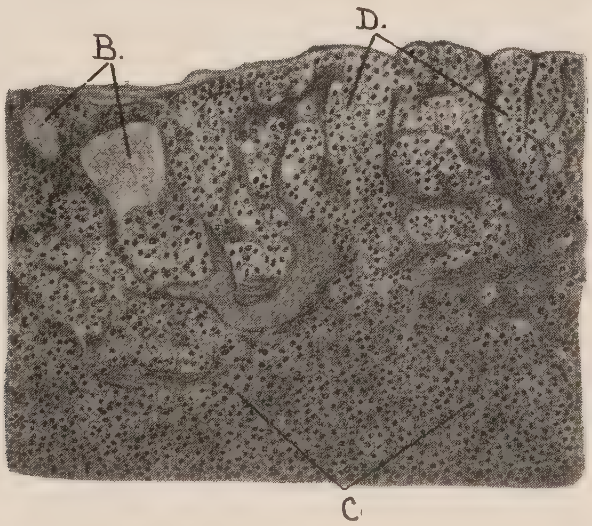


FIG. 291.—Small area of a parathyroid. Tetany age 5 mos.; *C*, small dark cells of the center; *D*, zone of development showing large light cells which are absent at *B*, replaced by blood cysts (old hemorrhages). (*Haberfeld.*)

spasms, the most important cardinal symptom of tetany is the increase of the electrical irritability. This hyperexcitability affects chiefly the motor nerves (Erb), but the sensory and also the cranial nerves are similarly affected. There is marked increase of galvanic irritability.

Increased reaction to the faradic current is far less constant. For the test, in the adult the nervus ulnaris, in the child the nervus peronæus is employed.

Erb's Phenomenon.—This may be present in most of the motor nerves which are available for the test. It is considered the most important symptom of tetany, since no other condition is known in which it is present. During the free intervals of chronic tetany the galvanic excitability approximates the normal.

Hoffmann's Test.—The sensory nerves show an increased excitability toward the electrical current. The ulnar nerve is usually tested. Parasthesia of the supplied area occurs. Chvostek, Jr., found sensory reaction of the nervus acusticus; v. Frankl.-Hochwart, of the sense of taste, by means of the galvanic current.

Chvostek's Test.—Tapping over the area of distribution of the facial nerve. Facial twitchings are the manifestation of tetany. This test is valuable because of its technical simplicity. v. Frankl-Hochwart differentiates three grades of the phenomenon, according to the intensity. The phenomenon is very frequently present in tetany, yet even in pronounced cases it can be absent and often shows great fluctuations (Falta). The light degrees are seen in numerous cases of neurasthenia, hysteria, and epilepsy. v. Frankl.-Hochwart and Schlesinger found Chvostek II and III in nearly half of the patients with pulmonary tuberculosis, and in many of these, caseation of parathyroids was present. This symptom is noted frequently in rachitis (Falta). The phenomenon is particularly frequent in all possible kinds of cachexia, especially if this is accompanied by loss of water in the body.

Trousseau's Phenomenon.—Pressure on a nerve trunk of an extremity. The result is a typical tetanic attack in the area supplied by the nerve. This phenomenon has nothing to do with alterations in the circulation, but rests on the excitability of the nerve itself (v. Frankl.-Hochwart). The sign is demonstrable in two-thirds of all cases of tetany. Schlesinger states that a mixed nerve is necessary for this phenomenon. The coincidence of epileptic attacks with tetany is not rare (v. Frankl.-Hochwart, Freund, *et al.*). Tetany is to be differentiated from tetanoid manifestations, especially hysterical. In hysteria, the reaction to Trousseau's sign is sudden; in tetany it is gradual.

Treatment.—The occurrence of tetany following operation on the thyroid is today rare in the hands of the experienced. This result is due to improved operative technique which, in turn, is based on a more exact knowledge of the usual and also exceptional topography of the

parathyroidal tissue. In 52 cases of thyroidectomy in the Billroth Clinic tetany occurred 12 times (23 per cent.). Nine of the 12 patients died, two developed chronic tetany, and one recovered. In 1890 von Eiselsberg stated that 30 cases of tetany had been observed following extirpation of the thyroid. Of these, seven are said to have recovered, three became chronically affected, and 13 died. Results in the remaining cases unknown (cited by Halstead). Halstead states that a number of cases of post-operative tetany have been observed, some of them for years, by various surgeons. Failure of tetany to develop in those cases in which total thyroidectomy had been performed with ligation of both thyroid arteries is explained on the basis that the existence of an anterior and posterior pharyngeal arterial anastomosis sufficed to insure the vitality of the parathyroids (Ginsburg). Haberfeld *et al.* have demonstrated hypoplasia of the parathyroids traceable to hemorrhage resulting from pressure and congestion during birth. In some such cases the absence of valves in the parathyroidal veins has been noted and considered contributive to the hemorrhage. The existence or absence of this hypoplasia cannot be determined at operation, therefore, preventive treatment, in the form of careful surgical technique in operative procedures on the thyroid, is the first consideration. In our experience, by performing thyroidectomy within the capsule and bearing in mind the parathyroidal zone, we have been successful in avoiding the untoward effects of injury to these little bodies. During this operation the parathyroids are rarely seen. Any tissue removed, which, in the slightest degree, suggests these glandules, is immediately implanted on the remaining thyroid beneath the capsule in a cavity free from hemorrhage. In general, the results of treatment of tetany have not been very satisfactory. The effect of the usual sedatives is frequently *nil.* Successes have been reported from the employment of venesection (Levi) and lumbar punctures (Narbut). MacCallum and Voegtlin have demonstrated the value of certain salts, particularly those of calcium. The method of administration is either intravenous or in large doses by mouth. The effect is admittedly transitory. MacCallum has reported benefit resulting from the intravenous injection of parathyroidectomized dogs with very large amounts of the prepared parathyroids of the same species. Branham cites a recovery following the employment of an emulsion of fresh parathyroids in a case of tetany after thyroidectomy. The treatment seemed to tide the patient over until the injured parathyroidal tissue regained its normal condition. The use of Beebe's nucleo-

proteid is supported by many. Halstead has reported an interesting case of post-operative tetany which was apparently benefited after several months from treatment with the dried parathyroids of beeves. The reported results from treatment of tetany with the extract of thyroid are rather generally viewed with scepticism. The results of transplantation of the parathyroids are divergent, but the history of this phase of the subject contains successes sufficiently supported to stimulate encouragement and painstaking research. A reserve functional power of organs in general is now a recognized fact. The amount of this reserve varies in different structures, but a conservative average would be four to six times. It has been experimentally shown (Halstead) that a very small portion of parathyroidal tissue suffices for maintaining the function of these glandules. It is probable that in the normal state of the body one active, at least hyperplastic, parathyroid would suffice. Pool and others made the important observation that compensatory hypertrophy of the remaining parathyroidal tissue resulted where one glandule has been removed. The probability of this compensatory process occurring should be considered in attributing to therapeutic measures the good results in tetany following operations on the thyroid. It has been demonstrated that parathyroidal tissue, which, though hypoplastic, is functionally sufficient under normal conditions of the body, may become relatively insufficient in the presence of some intercurrent disturbance. In this potential state of tetany strict attention to the general condition of the body is indicated. It has been stated by several authors that of fundamental importance and as effective as any measures in the treatment of the disease are rest in bed, a diet very limited in meat, frequent warm baths and tonics. The effect of gastroenterostomy on gastric tetany is noteworthy. In 21 operated cases, 17 remained cured (Wirth). Some recommend immediate operation, others prefer to await the results of internal treatment. Positive pyloric stenosis is the indication for gastroenterostomy (Falta), but the rather frequent simulations of this condition must be considered and excluded. In a series of 8,500 operations for goiter in this clinic, one case presented manifestations of tetany. The condition subsided, leaving doubt as to its true nature. The extract of thyroid and other measures were employed, but their effect was questionable.

Summary.—Investigations on the problem of the parathyroids have been various, very extensive and by numerous observers. An impressive fact to be learned from an analysis of the work is the rather wide divergence in results, theories and opinions among men of equally

high standing in the profession. Viewed in this light, the parathyroids must be held as structures concerning which little knowledge that is exact exists. It would seem that many experimentalists have entered the field of the parathyroids with minds that were prejudiced by a preconceived theory or opinion. Scientific essentials in the form of parallelism of factors have not been duly heeded, resulting in discordant deductions because of inharmonious premises. Our knowledge of increased activity of the parathyroidal tissue is practically *nil.* No manifestations of hyperactivity of these glandules, even in the presence of hypertrophy or adenoma, have been observed. Though the parathyreoprivous theory of tetany has its adversaries, still the summation of experimental work presents a preponderance of evidence showing that an extensive loss of the parathyroidal tissue, destruction or serious injury of its blood supply may produce tetany. It is a noteworthy fact that in all reported cases of tetany following operations on the thyroid in the human being, there has been great reduction of the glandular tissue of the thyroid. Usually both lobes have been operated upon, the portion left being injured in its blood supply and venous return, which evidently carries a large amount of glandular secretion. Though not themselves removed, the parathyroids may suffer a great loss in their blood supply, which may later be restored. Repair of this nature, likewise compensatory hypertrophy of remaining parathyroidal tissue, may explain many recoveries from tetany which have been ascribed to therapeutic measures.

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SECTION XXI

THE THYMUS

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The thymus was originally designated as a mere component of the lymphatic apparatus, but the evidence, which has accumulated since Plater first discussed the so-termed "thymic death" in 1614, is sufficient to prove that this gland belongs to the organs of internal secretion. To the extensive investigations of Friedleben, Hammar, Maximow, v. Sury, Schridde, Ronconi, Pappenheimer, Hart, Klose and Vogt, Matti, Tandler, Vincent, *et al.*, are we indebted for the advancement which has been made in our knowledge of the thymus. Results and deductions from the various investigations present considerable divergency, but from the summation of these contributions a substantial step forward has been taken toward the solution of the problem.

Embryology.—The thymus arises as a paired organ from the ventral portion of the third branchial cleft. This is the principal anlage, but it is maintained by some that there is also a rudimentary outgrowth from the ventral wall of the fourth branchial cleft (Fig. 292.) Since also the parathyroids arise partly from the third and the lateral thyroid from the fourth branchial cleft the thymus is at least topographically closely associated with these glands during development. At birth the thymic gland lies behind the sternum, extending downward to the pericardium and upward somewhat above the incisura jugularis.

Histology.—Hammar defines the thymus as an "epithelial organ, which is permeated with lymphocytes." The gland is therefore, viewed as of entodermal origin, with a secondary ingrowth of mess-dermal structure. However, with regard to the origin of the lymphatic elements a wide diversity of opinions still exists. Stöhr assumes their origin to be from a division of the epithelial portion. The entodermal origin of the reticulum cells and of the Hassal bodies is well supported by the examinations of Hammar.

Two phases in the existence of the thymus are recognized: (1) progression; (2) regression. A variety of views exists as to the various

incidents in these phases of the gland. The prevailing opinion is that the weight of the organ continues to increase after birth and ceases normally only at the time of puberty (Hammer, v. Sury, Schridde, Ronconi, Pappenheimer, *et al.*). During this physiologic involution the thymic tissue gradually atrophies and is partly replaced by fat. The older view, that the glandular structure completely disappears early in life, is not now accepted. Remnants of thymic structure are

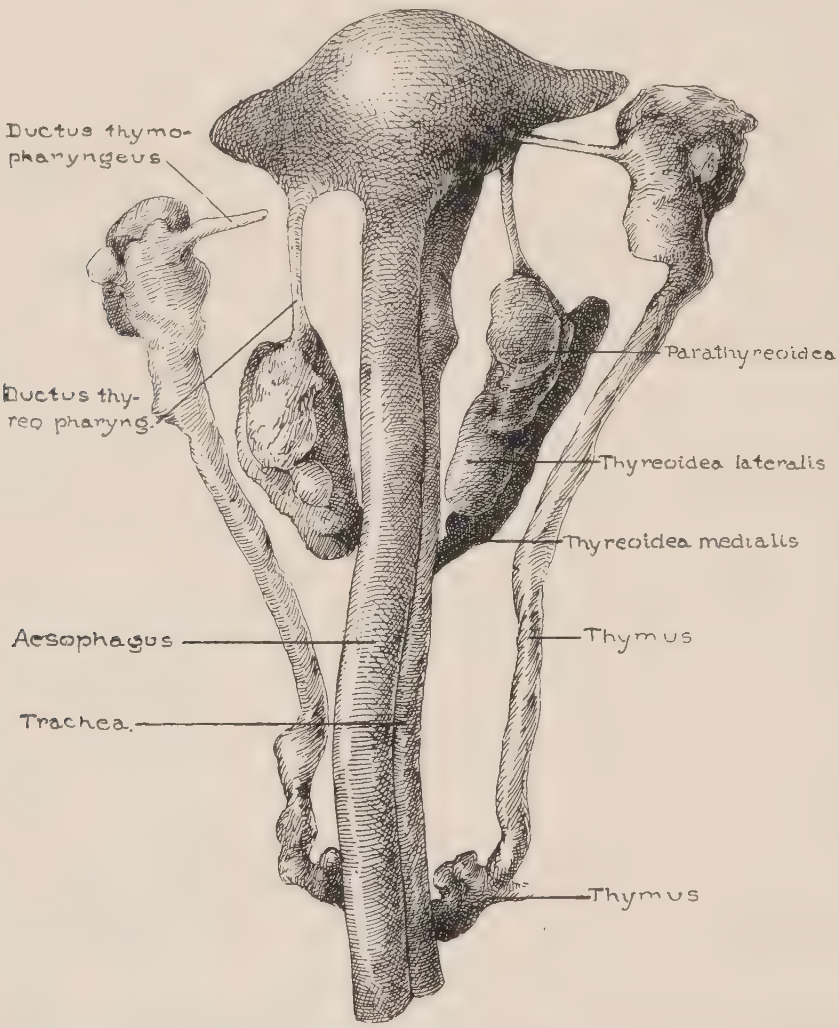

FIG. 292.—The anlages of the thymus and thyroid of a human embryo, 18.5 m.m. View from behind. (*After Kollmann.*)

commonly seen even in the very old. Hammar observed mitotic increase of lymphocytes and new formation of Hassal bodies in the later years of life. Perhaps one of the most fertile sources of error in estimating the various phases of the thymus is failure to appreciate the causes and frequency of "accidental involution." Wharton (1659) observed this involution in animals after excessive exertion. Friedleben and later Hammar noted a similar effect in starving animals. Hart emphasizes the causal rôle of the common infectious diseases of childhood in atrophic changes of the thymus. Accidental involution

is found in many chronic diseases which lead to marasmus (Falta). The results of all investigations agree on the pronounced sensitiveness of the lymphatic elements to X-rays. The epithelial portion of the gland proves to be more resistant and assumes the active rôle of phagocytosis. Rudberg has observed regeneration of the thymic elements after the thymus had been exposed to X-rays. Heineke had already noted relatively rapid restoration of the lymphoid tissue in the lymphatic glands, spleen and the marrow of bones. Friedleben states that complete regeneration of the thymus can occur, as shown in animals which had been reduced nearly to inanition and then re-fed to overweight. The question of regeneration after disease has been but limitedly investigated and little discussed.

Anatomy.—Obviously, the size and weight of the thymus varies with the period of its existence. The figures reported by different investigators vary within wide limits. In 495 patients under five years of age, Howland found the average thymic weight 4 to 6 gm. Dudgeon's estimate is 5 to 7 gm.; Klose's, 5 to 14 gm.

The thymus is of grayish red color, has an irregular, flat, oblong shape, and consists of two unusually asymmetric lobes—*lobus dexter* and *lobus sinister*—united only by a loose connective tissue. Each of these lobes is composed of a large number of small lobules—*lobuli thymi*—which are separable from one another, but are all connected by a medullary cord—*tractus centralis*—which follows a tortuous course inside the thymus. The gland lies just behind the sternum, in the *spatium mediastinale anterior;* it is bounded behind by the upper part of the pericardium, the vena cava superior, venæ anonymæ, the arcus aortæ and its branches; laterally and partly in front, by the pleura mediastinalis. Above, it may reach behind the musculi sternothyreoidei as far as the glandula thyreoidea. Its anterior wall is loosely, the others more firmly, connected with the surrounding tissues. The thymus is described as attached to the thyroid by the thyrothymal or suspensory ligaments.

Physiology.—Since Friedleben (1858) presented his extensive work on the physiology of the thymus in health and disease, there have been numerous contributions by many investigators on this phase of the subject. Despite this fact, in reviewing the field of accomplishments one is forced to agree with Wiesel's statement, namely, that "the problem of the functional importance of the thymic gland is almost completely unsolved." Throughout the experimental work which has been done, there is, at least in many of its phases, an impressive lack

of uniformity in results. The main modes of experimental investigation have been observations on the effects of extirpation of the thymus, hyperthymization, and the relations of the thymic gland to the other organs of internal secretion. Negligible ill effects, transitory and persistent serious disturbances are among the reported experimental results from removal of this gland. An important factor in this divergence of effects is diversity in the period of thymic existence in which operation was performed. Results have been positive and rather uniform when extirpation of the thymus has been done in the early days of the animal's life. Another source of erroneous conclusions has been the simultaneous injury of other structures, as, for example, the parathyroids. The causal rôle attributed to the thymus in tetany is probably ascribable to this error. The most important and generally accepted sequence of experimental thymectomy is disturbance in the development of the skeleton (Friedleben, Basch, Klose and Vogt, Matti, *et al.*). This is manifested by a diminution in the length and weight of the bones, also by a pronounced softness, pliantness or frangibility. This physiologic deficiency in osseous structure results in defective development, various deformities, and fractures with non-union because of insufficient callus formation. The histologic picture is atrophy of bone. Undissolved calcium is diminished about one-half. During the period of osseous growth this deficiency of calcium conduces to rachitis, abnormal flexibility of bone; after this period the results are osteomalacia, and, finally, osteoporosis, abnormal frangibility. Resultant motor, sensory and cerebral phenomena have been described by Klose and Vogt. The general picture of these manifestations is a dulling, *idiota thymopriva* (Beidl). Changes in the condition of the blood have been studied by several investigators with various results. The decrease in hæmoglobin, erythrocytes, and leucocytes observed by some has been found to be transitory by others. The spleen and the pancreas particularly have been noted enlarged. The splenic hypertrophy is considered compensatory for the absent thymus (Klose and Vogt). Hyperplasia of the thyroid following extirpation of the thymus is maintained by some authors, but denied by others. In guinea-pigs Paton observed a rapid growth of the testicles following thymectomy done before puberty; after this period the operation had no effect on the weight of these structures. The observations of U. Soli, confirmed by Lucien and Parisot, disagree with those of Paton. The latter's results are supported by Klose and Vogt.

In the absence of the thyroid, the thymus has been observed en-

larged by several authors (Cadeac and Guinard, Gley). Others have reported decrease in the weight of the thymus after extirpation of the thyroid. Pronounced thymic atrophy has been noted in the case of death from cachexia thyreopriva. After thyreoparathyroidectomy an increase of the medullary portion of the thymus at the expense of the cortical, with marked hyperæmia of the gland, has been described (Pigache and Worms). Where atrophy occurs in these conditions, the possibility of accidental involution is to be considered. Two effects have been noted from feeding with thyroid: hyperthyroidization, an indirect depressive action on the thymus, manifested by general disturbances of nutrition; and a direct, specific, exciting effect. The result is dependent on certain factors, chief of which is the amount of thyroid administered (Utterström). Hoskins observed increase in size of the thymus in the offspring of guinea-pigs fed with thyroid. The hypertrophy affected principally the cortex. Hoskins considers the enlargement of the thymus as a direct stimulating effect of the thyroid hormone, and suggests an analogy of his finding with the thymic hypertrophy observed in Basedow's disease. An increase of the weight of the thymus occurs after removal of the adrenals (Boinet, Calogero, Auld). After injections of extracts of the cortex and medulla of the adrenals, Wastenson observed a diminution of the thymus. The influence of the genital glands on the thymic gland is most important. Their removal is followed by increase in weight of the latter organ (Calzalari). This effect of castration has been mentioned by Hammar, Tandler and Gross. Adler injected guinea-pigs and rabbits with extract of the fresh thymi of calves, and estimated the adrenalin-content of the blood. A constant increase of adrenalin was observed after the preliminary administration of thymic extract. The author interpreted this to indicate that the adrenal system, by an increased production of adrenalin, is concerned in diminishing or abolishing the hypotonic influence of the thymus. By injecting thymic extract, Yokoyama has shown that the effect of adrenalin in raising blood pressure is diminished or prevented, and this, the author believes, is a proof that the thymus acts hypotonically. Svehla was the first to note that the intravenous injection of an aqueous extract of the thymus produces acceleration of the cardiac beat and lowering of the blood pressure. However, Vincent and Sheen *et al.* emphasize the fact that similarly acting depressive substances can be extracted from many other tissues. These circulatory disturbances Popper attributes to the general peculiarity of tissue extracts in producing intravascular clotting. Biedl states that this effect

of the thymic extract may stand in relation to the content of the gland in cholin. The results of implantation of the thymus have been in general negligible.

Pathology.—Among the conditions which have been reported are: absence of the gland; changes considered post-mortal; effects of the infectious diseases of childhood, over-exertion, starvation; circulatory disturbances; acute inflammatory processes; tuberculosis; syphilis, neoplasms, and status thymicus. Absence of the thymus in the human is rare. Bourneville reported absence of the gland in 25 out of 28 mentally weak children. Hart (1912) has pointed out the degenerative effects on the thymus of various infectious diseases, particularly the ordinary diseases of childhood. Hemorrhage in the gland is not infrequent. It has been observed in association with whooping cough, measles, hemophilia, phosphorus poisoning, syphilis and, most frequently, with pneumococcic infection. Hyperæmia occurs with respiratory and circulatory disturbance. Some authors state that hyperæmia follows ligation of the inferior thyroid artery and may at times cause serious effects. Abscess and tuberculosis of the thymus are usually secondary. Syphilis of this gland is rare. It is usually present in the form of diffuse interstitial inflammation. Some cases of gummata have been reported. The Dubois abscess is considered by some authors (Weisflog, Schlesinger, Chiari, *et al.*) as characteristic of lues. Neoplasms have been reported by several, but according to the present view the history of thymic tumors needs revision. The determining points advanced for the diagnosis of these growths are position and thymic rests, particularly Hassall's bodies. The gland is affected by both primary and secondary tumors. Neoplasms of epithelial origin are rare. Carcinoma is considered a growth from the epithelium. Tumors of the connective-tissue type are much more frequent than epithelial growths, but the number reported has diminished under closer analysis. Lymphosarcoma is the most commonly observed. Sarcomas of the thymus may reach a very great size. Cysts are found under a great variety of pathologic conditions. Care is necessary before designating a tumor thymic.

Status Thymicus.—This is one of the most interesting and extensively studied phases of the thymus. In a recent comprehensive work on the pathology of this gland, Hart concludes as follows: "There is a genuine persistence and a genuine primary hyperplasia of the thymus, with which not only an excessive but also a defective function of the organ is frequently, perhaps even always, associated. These

are an expression and local manifestation of an abnormal constitution, a disturbance of equilibrium in the polyglandular system of organs of internal secretion, on the basis of which different affections can develop. A poisonous effect on the heart appears to result from the hyperplastic thymus. Up to the present, the occurrence of a genuine status lymphaticus has not been proved. The swelling of the lymphatic apparatus appears much more to show a tissue reaction dependent upon the thymus, which can be manifested also on the lymphoid components of the thymus itself. There occur two sharply differentiable histologic types: the so-called medullary hyperplasia, which presents a primary

FIG. 293.—Case 40237 (exophthalmic goiter) Thymus-weight 38 G. Autopsy specimen.

increase of the specific components of the organ; and hyperplasia of both zones in somewhat normal proportions, which shows a secondary increase of the non-specific lymphoid elements in a mostly primarily hyperplastic thymus." The conditions which have been mostly discussed in relation to enlargement of the thymus are the so-called thymic death and thymic asthenia. Hammar states that only a few of the cases in the literature fulfil the essentials for determining increased size of the gland. The diagnosis of genuine thymic hyperplasia is difficult and a source of erroneous deductions. Certain serious disturbances in the presence of the enlarged gland have been attributed both to its mechanical action and its toxic influence. Today the mechanical theory for sudden death is considered by most authorities as untenable, excepting, per-

haps, for isolated cases among helpless infants. In many of the reports of sudden death from thymic enlargement the presence of serious conditions, for example, capillary bronchitis and intestinal diseases, have not been duly estimated. On the other hand, anatomic investigations and the results of thymectomy support the view that considerable circulatory and respiratory disturbances may be caused by the mechanical effect of the enlarged thymus. This has been our own experience. Despite the enormous work which has been done with regard to hyperthymization, little of positive knowledge has been acquired. The importance of thymic hyperplasia in status thymico-lymphaticus is doubtful. As Biedl remarks, it is a question whether the

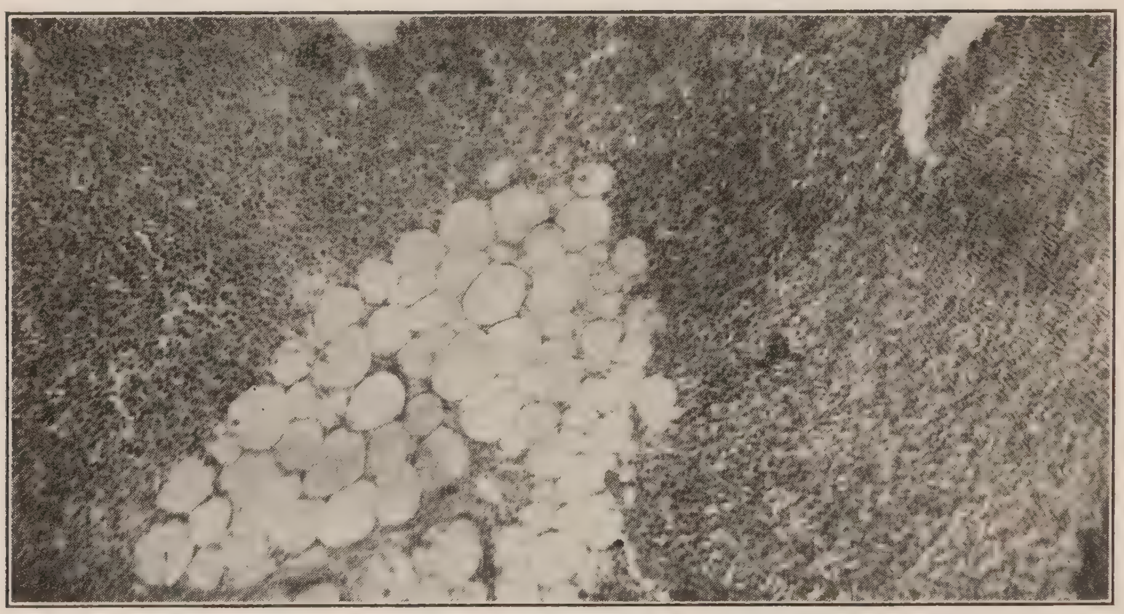

Fig. 294.—Low power photomicrograph from specimen in Fig. 293.

enlargement of the gland forms a coördinated local manifestation of the constitutional anomaly, or presents only a subordinate sequence from anomalies of other organs of internal secretion which are correlatively associated with it. Thymic hyperplasias are found in cases of exophthalmic goiter (Figs. 293, 294, 295, 296, 297, 298), apparently also in acromegaly, pituitary dystrophy, myxœdema, eunuchoidismus, etc. (Falta). Consequently, it may be present in either excessive or diminished glandular function. Caution should be used in the diagnosis of status lymphaticus. Glandular reactions to various infections, particularly in the young, are to be excluded. To the pathologic picture of status thymico-lymphaticus belong, beside hyperplasia of the thymus and the lymphatic tissues, cardiovascular hypoplasia, altered sex-characteristics, and hypoplasia of other structures, for example, the chromaffin system. The anatomically demonstrated association of non-tuberculous Addison's

FIG. 295.—Case 41153 (exophthalmic goiter). Thymus, weight 46 g. autopsy specimen.

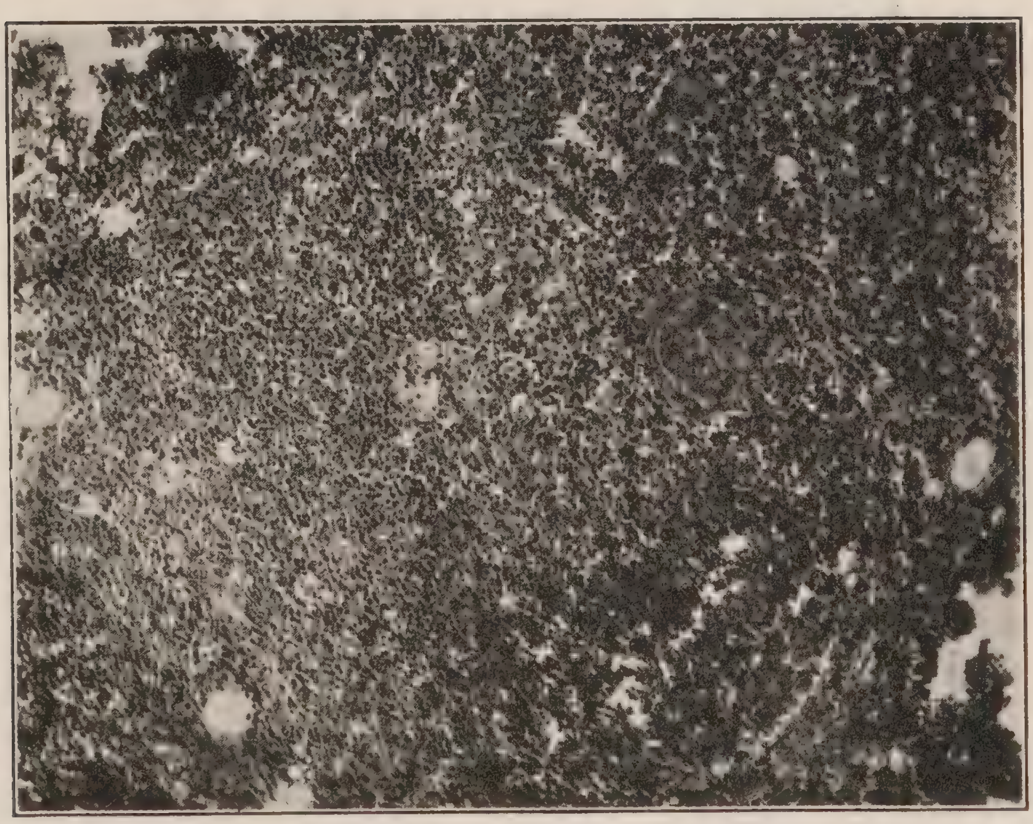

FIG. 296.—Low-power photomicrograph from specimen in Fig. 295.

disease with status thymico-lymphaticus or status lymphaticus is noteworthy. The importance attributed by some to the occurrence of thymic persistence or hyperplasia with goiter is, in the present light, to be viewed with scepticism. Whereas this association is comparatively frequently met, yet, even in some cases of severe exophthalmic goiter, the amount of thymic tissue present is almost undiscernible grossly. Thus, in a series of 12 autopsies in this clinic on patients with goiter, 4 showed little more than fatty tissue in place of the thymus, while the remaining

FIG. 297.—Case 43179 (exophthalmic goiter.) Thymus, weight 55 g. Autopsy specimen.

8 cases presented thymic substance varying from 2 to 92 gm. In 96 autopsies on patients with other conditions the thymus was notably enlarged in one case. Whereas, in these examinations the gland was prominently persistent or hyperplastic in a much greater percentage among the goiterous cases than among the cases with other conditions, yet the finding was not sufficiently constant, and, in several, the amount of thymic tissue too inconsiderable to support the causal rôle attributed by some to the thymic gland in goiter.*

*Since writing the above a review of the necropsy findings has been made in 62 cases of exophthalmic goiter and in 24 cases of simple goiter. Thirty goiterous individuals under the age of 30 have uniformly shown marked thymic hypertrophy (7 non-operative, 11 post-operative exophthalmic goiters, and 2 post-operative simple goiters).

Forty-three patients more than 30 years of age who were suffering from exophthal-

Clinical Diagnosis.—The diagnosis of enlarged thymus is not easy. Park and McGuire maintain that from anatomic study of cases at autopsy the methods of percussion of the thymus based on the theory of thymic mobility are founded on a false anatomic hypothesis. Occa-

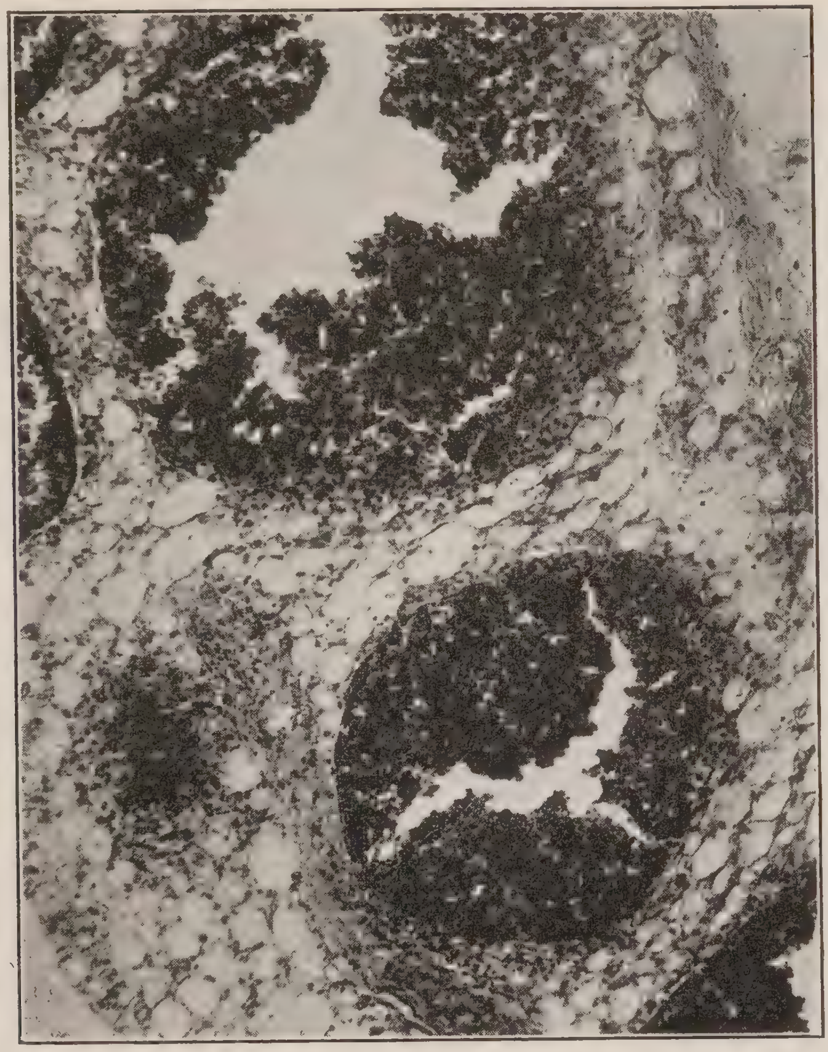

FIG. 298.—Case 41395 (exophthalmic goiter). Low-power photomicrograph from a slightly enlarged thymus.

sionally one may feel the thymus if the patient be placed in the prone position and palpation made in the suprasternal notch. Opinions vary as to the value of the X-rays, but it is conceivable that, with improved technique, this may prove to be a reasonably reliable means of diagnosis (Figs. 299 and 300). Continued research work on the blood and the

mic goiter were examined. In 12 the onset of symptoms was before the age of 30 and 75 per cent. of these showed marked thymic hypertrophy. In 31 the onset occurred after the age of 30 and 16 per cent. of these showed marked thymic hypertrophy. In the 22 necropsies, in cases of simple goiter (age more than 30), there were 9 per cent. with hypertrophied thymus.

We have not been able to confirm certain recent observations which hold that thymic hypertrophy is associated with a certain severity or type of goiter intoxication. The only relation now evident is the uniform presence of hypertrophied thymus in young individuals suffering from goiter, and a fairly definite association between goiter and hypertrophy of the thymus.

physiologic and pathologic interrelationship of the glands of internal secretion may result in valuable aid to diagnosis. A child presenting respiratory difficulties and circulatory disturbance about the head and neck should direct attention to the thymus, in the absence of other causal

Fig. 299.—Case No. A56897. Enlarged thymus confirmed at operation—X-ray No. 12820.

factors. Tumors of the thymus grow slowly, and the first signs usually noted are those due to respiratory obstruction. This may occur suddenly or gradually develop. Other signs noted are those resulting from pressure on vessels or nerves. Tumors arising from neighboring structures may be misleading. Lutelle states that, in general, malignant

growths of the anterior mediastinum are thymic. Metastasis has been commonly observed in the regionary lymphatic glands, the pleuræ, lungs, kidneys, pancreas and spleen. Positions of the growth and thymic rests, particularly Hassall's bodies, are given as the determining points

FIG. 300.—No. A62264. Intra-thoracic goiter confirmed at operation—X-ray No. 14125.

for diagnosis of thymic tumor, but the absence of Hassall's bodies does not positively exclude this diagnosis.

Treatment.—The modes of treatment which have been recommended are medical, X-ray and operative. The effects of medication must be at best slow, indefinite, if not absolutely negative. The results from

the employment of the X-rays are variously reported. Whereas in some cases the beneficial effect has been rapid, in others it has been slow, and in still others Röntgen therapy appeared to have no influence on the condition. According to some authorities, the good results may not be lasting. To say the least, this mode of treatment is indefinite and rather uncontrollable in its action. Oliver states that the operative treatment of hypertrophied thymus is the only reliable and curative measure that can be applied. This author reports 42 thymectomies with 23 cures. The operation relieved dyspnœa in 25 out of 28 cases, the crises of suffocation in 10 out of 12, and the stridor in 12 out of 16. There were 15 deaths in the 42 cases, most of which occurred through sepsis, which was due to the complications of tracheotomy or possibly to difficulties of drainage. Pedrazzini prefers chondrotomy of the first costal cartilage. The author states that this operation is simple, relieves compression, and that it usually has to be done as an emergent intervention. Hart maintains that tracheotomy is not a good procedure. Klose and Vogt have reported eight tracheotomies which were fruitless. Chevalier Jackson extirpated the thymus, with permanent recovery, after having secured temporary relief with tracheotomy. Only one case (König) has been reported in which the untoward effects of insufficient thymic function followed thymectomy. It may be that this condition is not more frequently observed because operation is done late in the existence of the gland. However, especially in the infant, total thymectomy should not be done; a portion of functional glandular tissue should be left in place. The *subcapsular* operation is the procedure of choice.

Operation.—A curved transverse incision, which includes skin and platysma, is made low in the neck. The inner borders of the attachments of the sternomastoid muscles are incised; the sternohyoids are cut across. If the thymus be enlarged, it is seen as a pinkish gland projecting into the neck from behind the sternum. The gland may now be caught gently with clamps, and drawn upon until the fingers can be used for direct traction. The vessels are not large, the fascia which incloses the gland is loose, and there is but little difficulty in clamping and ligating as one lobe is removed. If it be deemed necessary, the second lobe can be elevated and a portion of it excised. The cure is complete. A drain should not be used unless indications for drainage are urgent. In case it be advisable, a folded strip of rubber tissue should suffice for the few hours during which drainage may be necessary.

Summary.—1. The thymus is an organ of internal secretion and of essential importance in the early developmental processes, particularly in those of the osseous system.

2. The life of the gland consists of two phases—one of progression, the other of regression. The former continues to the time of puberty. Besides the physiological involution, accidental involution may occur from various causes, and is not infrequent. The latter form of involution has been a source of error in estimating the gland. Remnants of thymic tissue are commonly present in adult life, even in the latest years.

3. Hyperplasia of the thymus occurs, but the question of hyperthymization is far from solved. That the enlarged gland may mechanically cause disturbance is accepted, but that it is the factor in sudden death, excepting, possibly, in isolated cases of helpless infants, is sceptically viewed.

Respiratory and circulatory disturbances in the region of the head and neck, particularly in children, should direct attention to the thymus, other causal factors having been excluded.

4. Subcapsular thymectomy is the treatment of choice. The operation is usually not difficult; its beneficial effects occur early and are definite.

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SECTION XXII

SURGERY OF THE HEART, PERICARDIUM AND DIAPHRAGM

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The surgery of the heart is dangerous. Experimental investigations of the past few years have demonstrated methods of lessening these dangers not only through the construction of reliable apparatus to aid the impaired respiratory mechanism, but further by the development of elements in surgical technique which will in the future lower the mortality of chest operations.

Heart Injuries.—Sudden death is the usual sequel to gunshot and stab wounds of the heart. A small proportion of such injuries are followed by an interval of considerable length in which time surgical aid should be, but rarely is, seriously considered. The gravity of symptoms presents a picture gruesome and horrible. The surgical risk is obviously extreme. General surgeons, no one of whom can thus far claim any particular operative experience with such cases, influenced undoubtedly by the frequent criminal aspect of the situation, and justly skeptical as to the surgical outcome, naturally shrink from interfering, and leave the patient to live or die as fate may decree. The victim is already dying in consequence of assault. Operation seems for the moment like a repetition of the crime, and surgeons tend to leave such situations in the hands of God, lawyers and police officers.

This not uncommon attitude should cease, and the results accumulated by responsible writers indicate that the mortality in bullet and stab wounds of the heart is lower in the recorded operated cases than in those left to their natural outcome. Forty-five per cent. of the operation cases in 13 years have been cured, while without interference but 15 per cent. have recovered.

This chapter deals with heart wounds. At least three-quarters of such injuries are complicated by trauma to the pleura and lung. The primary element in the management of thoracic injury from knife or

bullet is to determine whether or not the heart is perforated. In cases of lung or pleural trauma without heart wound, expectant treatment is generally the one of choice, and operation may readily render a situation fatal which might have pursued a favorable course if expectantly treated.

If, however, a heart wound is present with or without lung injury, expectant treatment is attended with the greater risk.

Diagnosis.—With rare exceptions, definite diagnosis of cardiac wounds is impossible. Heart injuries are so commonly associated with wounds in the lung and pleura, that, although the latter may be diagnosed, uncertainty invariably exists as to the heart involvement.

A small proportion of stab and bullet wounds of the chest are confined to the heart, and such cases are most likely to be correctly diagnosticated. Hemorrhage from the heart is confined to the pericardium and the anterior mediastinum. As the hemorrhage increases, the pericardial opening sometimes becomes occluded and the condition known as "heart tamponade" arises. As the intrapericardial tension increases and the heart labors against it, a group of symptoms develops which is almost pathognomonic of the condition: pain in the arm, a sense of constriction of the heart, dyspnœa, profound shock, and cold sweat are characteristic. A whirring sound in the cardiac region occurs infrequently. Several surgeons have in common discovered a symptom which is not noted by some others, namely, absence of radial pulse in the left wrist, accompanied by a weak and scarcely palpable pulse in the right wrist (Fischer, Borzymowski, Tscherniachowski). Luxembourg lays emphasis on the feature that in the presence of heart tamponade the symptoms of air-hunger, dyspnœa, and pain, while distressing when the patient is recumbent, are relieved by a sitting posture. Auscultation and percussion invariably reveal an enlargement of the heart area, which is further demonstrated by the radiograph. If this enlarged heart shadow is in the line of the point of entrance and exit of a bullet, or coincides with that area toward which the canal of entrance of a stab wound is pointing, further evidence of hemopericardium is furnished.

As hemopericardium continues, the right side of the heart is compressed, the blood from the large veins ceases to enter the auricles, the ventricles are soon emptied and the heart, now devoid of blood, ceases to beat.

Although this condition of hemopericardium may usually be recognized and may even be verified by exploratory puncture, pleural com-

plications render the diagnosis of heart injury uncertain. Flatness at the base of the left chest with symptoms of hemorrhage indicate hemothorax at least. This accumulation of blood may come from the lung or from the pericardium, or from both. In many cases, with hemothorax there exists also a hemopneumothorax. If the injured pulmonary vessels alone produce the hemorrhage, the neighboring air-passages are at the same time opened. A wound in the pleural lateral aspect of the pericardium may result in profuse hemorrhage from the heart into the pleural cavity, but such a wound is impossible without concurrent laceration of that portion of the upper lobe of the lung which borders the pericardial region.

An extensive accumulation of blood in the left pleural cavity obscures the left border of the heart dulness and may also displace the heart to the right, so that percussion and radiography may give the same appearance to the right of the sternum as does hemopericardium. Dyspnœa, shock, air-hunger, and signs of hemorrhage may all be present from lung injury alone. If the heart is transpleurally injured, hemopericardium does not exist because the heart blood leaks into the pleural cavity. In such instances, therefore, we lack the characteristic symptoms of pericardial tension, which stamp the diagnosis of heart wound alone.

Treatment.—It may be said that expectant treatment is indicated in but one group of heart wounds, namely, that in which a small wound in the heart muscle is occluded by clot formation in the pericardium before the fatal results of heart tamponade ensue. Close observation in such instances reveals probable heart injury alone. As signs and symptoms develop, there may be indications that the hemorrhage is self limited by the pericardium. Operation occasionally may be needless under such circumstances.

With this one exception, in which expectant treatment may be indicated, an operation should be promptly and seriously considered in every case in which there is reason to believe that the heart is wounded. Obviously in those cases inevitably fatal in spite of all we can do, operation will only serve to raise the mortality of a series of operations which up to this time have justified their being.

Two new agents are now at our disposal in operating on these grave cases, and these agents should increase our enthusiasm to operate, namely, transfusion and intratracheal insufflation (or else differential pressure). Saline infusions have in the past been administered before and during reported operations for heart wounds with undoubted

stimulative effect. Transfusion at the moment of completing the heart suture should be of specific value to restore blood pressure and to provide the heart muscle with working material.

Inasmuch as pneumothorax is associated with at least seventy-five per cent. of heart injuries, collapse of the lung may occur either before or during the operation. Writers have been loath to credit a death from operation on heart wounds to the effect of pneumothorax, either previously produced or resulting from the thoracotomy, for in the presence of profound hemorrhage and manual and instrumental trauma to the heart muscle, the presence of air in the pleural cavity seems of secondary importance and an inadequate excuse for the death. It cannot be denied, however, that collapse of the lung alone will cause changes in the pulmonary circulation, and that this collapse in certain cases markedly and even fatally restricts the respiratory function of the remaining lung. Whether this factor may in a given case be of great or partial significance, the prevention of this dangerous collapse is certainly of value.

Intratracheal insufflation, now an established method of maintaining a complete oxidation of the blood in spite of restricted respiratory function, should be employed in all operations for heart wound. If the apparatus is not at hand, ether under the pressure of an oxygen tank may, by resisting expiration, maintain inflation of the lung and thus improve the pulmonary circulation.

The advantages of intratracheal insufflation (or of differential pressure) at these operations are as follows:

1. Economy of time. With the employment of differential pressure the pleura may be opened widely. There is no loss of time and effort to avoid injury to the pleura, an effort usually unsuccessfully attempted in the extrapleural methods.

2. All anxiety concerning the possible fatal effects of pneumothorax is obviated.

3. Inflation of the lung discloses the injured areas in the lungs by the escape of air, facilitating their localization and repair.

4. Differential pressure, by maintaining the expansion of the lungs, prevents the sagging of the heart posteriorly, upward and to the left.

5. The reinflation of the lung at the end of operation, followed by tight closure of the intercostal wound, prevents the persistence of pneumothorax which leads to infection, the usual cause of death in these cases which survive the operation itself.

Technique of Operation.—The patient should be in the dorsal position with a low sand bag partially elevating the left chest. Preliminary ether anæsthesia is started, and the intratracheal tube is then introduced. During this interval the skin is prepared with benzine and iodine.

In determining the preferable method of approach in this group of cases, an attempt should be made to determine whether the pleura and lung also are involved. The point and angle of entrance of the bullet or knife will aid in this determination. If there be symptoms of heart tamponade—namely, hemopericardium, with increasing tension, and absence of signs pointing to intrapleural injury—an extrapleural approach through the precordial space is indicated; or in further detail, given a diagnosis of heart injury alone, a skin flap may be reflected which will include that part of the heart area designated by the external wounds. The wound should then be further explored. If injury to the base of the heart is suspected, resection of portions of the sternum may be required, together with two, three or more costal cartilages. For this approach to the heart *via* the anterior mediastinum, at least twenty different skin incisions and osteoplastic operations have been employed. The sternum may be bisected and partially resected. Two, three and four ribs may be divided and reflected outward or medianward, or resected for varying lengths with and without their cartilaginous portions. Flaps of skin, muscle, bone and pleura may be reflected, with division of the ribs at one edge of the flap and fracture at the hinge. The hinge of such flaps may be made toward the median line or away from it. The incision may start vertically over the sternum and extend laterally in a direction parallel to the underlying ribs. The cartilages of several ribs may be divided and intercostal incisions may be made above and below the upper and lower divided ribs respectively. The rib-and-intercostal-muscle flap may then be sprung away, exposing a window.

Intercostal Incision.—The precordial osteoplastic exposures mentioned above have been developed in consequence of the reluctance hitherto shown by surgeons to enter the pleural cavity. Experimental chest surgery has demonstrated the usefulness and safety of wide open thoracic intercostal exposures for approach to the heart, lung, œsophagus and diaphragm. The long lateral intercostal incision extending from the sternum across the axilla with separation by the use of a strong rib-spreader, was recommended by Mikulicz, and was successfully developed by Sauerbruch. Its advantages in heart injuries are

several. The lung may be carefully explored for accompanying wounds. The heart and pericardium may be freely exposed. This chest opening is ample to permit of manual compression of the great vessels. Pericostal silk stitches will closely approximate the ribs at the end of the operation and thus prevent post-operative pneumothorax, and unusual complication in these cases.

There is reason to believe that the ultimate technique for this group of injuries, involving either the heart or lung or both, will be the employment under differential pressure of this long intercostal incision, with spreading of the ribs and exposure of both the areas in question.

When the heart area has been exposed by one of the above-mentioned methods, although the pleural cavity may contain blood, and bleeding wounds of the lung be discovered, the pericardium should be carefully examined and the possibility of heart wound not forgotten, even in the absence of lacerations of the pericardium. Fourteen cases are now recorded of rupture of the heart muscle in the presence of an intact pericardium. Wilms explains this at first incomprehensible condition on the principles of hydrodynamics. It occurs presumably only in cases of bullet injuries. The elasticity of the pericardium may allow the bullet to administer a sudden blow upon the more resistant contracted heart muscle, which produces a rupture rather than a perforation of the ventricular wall. Luxembourg reports a case in which two bullets were found lying in the anterior mediastinum without perforation of the pericardium. Both bullets were removed and the operation abandoned. Death ensued, and autopsy revealed a double heart wound which resulted in hemopericardium and death. It would seem, therefore, that *in all cases of this group of chest injuries the pericardium should be incised if there is any accumulation of blood within it, lest one of these hidden heart ruptures be overlooked.*

It is at the moment of the pericardiotomy that the critical moment of these operations sometimes presents. All resistance to heart leakage which the pericardium may have hitherto provided is suddenly removed. Sometimes the hole in the ventricle may be small and the hemorrhage slight. In some cases the immediate blood loss is terrific. If violent hemorrhage exists, an attempt to check it is of primary importance before attempting the suture. Loss of blood previous to this moment may also have been of great consequence. If the wound is in plain view, the stream spurting from a ventricle strikes face and eyes of the operator with surprising accuracy. One stitch,

when introduced and tied, is seldom enough to check the flow. Tension on the first stitch with the hope of checking hemorrhage is likely to result in tearing the heart muscle. Tension which may be endured by the muscle at diastole is suddenly increased at systole with a resulting tear. The trauma to the heart muscle causes immediate increased rapidity of contraction, and the introduction of sutures under these conditions of violent motion and hemorrhage is quite impossible.

Rehn, Haecker, Tigerstedt, Noetzel, Läwen and Sievers, and Elsberg have determined the length of time which animals will endure the compression of the great vessels at the base of the heart. Läwen and Sievers conclude that in closure of the vena cava the lung and coronary circulations remain intact for nine minutes in the rabbit, although distinct disturbances from cerebral anæmia are noted in the interim. For three minutes the veins may be compressed without disturbances of either heart or brain. They state further that complications can be lessened if the compression is remitted from time to time, even at the expense of a slight loss of blood. Sauerbruch concludes from experiments that the superior and inferior cavæ may be compressed for ten minutes, during which time the heart-beat is small and irregular. On removing the compression, the right ventricle becomes suddenly dilated, and the heart-beat momentarily ceases. A more extensive series of experiments by Haecker results in similar conclusions.

The writer has employed manual compression of the vessels at the base during repair of a bullet wound of the left ventricle. The heart suture was materially facilitated by the resulting hemostasis. One minute's compression upset the heart action, which was promptly restored when the pressure was omitted.

Experimental investigation, therefore, and a limited number of reported clinical attempts emphasize the advisability of intermittent vessel compressions during suture of heart wounds.

Looking further for means of hemostasis during heart suture, when hemorrhage is profuse, we find possibilities in the use of differential pressure. Sauerbruch, using negative pressure in experimental suture of artificial heart wounds, has noted that allowing the lung to collapse within safe limits has resulted in a slowing of the heart-beat and a concurrent diminution in the hemorrhage from the heart wound. He explains this phenomenon on the basis that the collapsed lung retains more blood than is normal to it, and that resultingly less blood for the time enters the heart. The slowing of the heart-beat, together

with slight dyspnœa, is a well-known symptom of the effects of pneumothorax and lung collapse, and many observers have been impressed with the control of the pulse-rate by raising or lowering the differential pressure.

As regards the technique of the suture itself, death has seldom occurred from subsequent leakage if the suture is once established; in fact one might even conclude that the kind of material is of comparatively little significance. Round needles and interrupted sutures, not including the endocardium, are to be preferred.

Drainage.—Of 112 cases of stab and bullet wounds of the heart which survived the operation itself, 76 (60 per cent.) had infections of the pericardium or pleura or both. Forty-one of these died and 26 recovered (Peck). A study of the individual infected cases shows that infection occurred a trifle more frequently with drainage than without. Rehn and Vaughan accept these statistics as evidence that drainage is not advisable except in cases where hemostasis has not been complete.

Drainage of the pleural cavity should not be established at the end of operation for two reasons:

First. If a virulent infection has been introduced at the time of injury or operation, the introduction of a drain to the pleural cavity will be insufficient to check the progress of an acute septicæmia. If, on the other hand, the infection is less virulent and confined to the pleura, there is probably no danger in waiting until the symptoms of empyema develop. Adhesions, too, may have occurred in the interim which will tend to localize the septic process. Drainage may then be established with a suction method, which will dispose of the infectious material without permitting complete lung collapse.

Second. It is a well-recognized fact that the presence of pneumothorax favors infection after operation. The presence of drainage at once establishes this infection.

In this connection it should be remembered that it is quite as important to obliterate the pleural space before closure as it is to omit drainage. If obliteration is neglected and the lung is left in the collapsed state, atmospheric pressure persists in one pleural cavity while the normal negative pressure remains in the unopened side of the thorax. The resulting inequality in the pressure of the two sides of the chest prevents the reëxpansion of the collapsed lung, and often causes a pleuritic transudate which serves as an admirable culture medium. To prevent this, normal negative pressure in the wounded

side should be restored, either by artificial inflation just before the tying of the last wall suture, or by aspiration after the closure of the wound. If differential pressure is at hand, the artificial inflation is employed without difficulty.

The resistance of the patient, not only to infection but to the blood loss and shock, is undoubtedly increased by the restored function of the collapsed lung. The balance between the pulmonary and aortic circulation is restored to normal, and the oxygenating lung surface is not reduced at this time of need.

Concerning drainage of the pericardium, the consensus of opinion is in favor of closure with subsequent aspiration if pericarditis ensues.

Closure of the thoracic wall wound is simple when an intercostal Sauerbruch incision has been made. Interrupted braided silk sutures should be used, encircling the two ribs above and below the incised intercostal space. All available muscle tissue should then be approximated with interrupted chromicized catgut. The artificial lung inflation should be maintained at least up to the completion of the muscle stitching. The skin is closed with a continuous silk suture.

Closing the osteoplastic flap wounds is more difficult. Air leakage is common. Great care should be exercised in utilizing muscle and fascia to seal the spaces between rib ends, sternal edges and cartilage fragments.

Cardiolysis.—(*An operation for the treatment of adhesive mediastino-pericarditis*).—Cardiolysis has been attended with sufficient success in ten years to justify its continuance. The operation is not intended for the relief of the common single adhesive pericarditis in which the layers of the pericardium are adherent to each other. It is applicable only to the pericarditis, characterized by the existence of adhesions between the pericardium, pleura, diaphragm and mediastinum and a general glueing together of the adjacent serous surfaces in the lower median segment of the thoracic cavity. Cardiolysis, furthermore, should not be confounded with Delorme's unpromising operation, the object of which is to separate these adhesions. Cardiolysis is an extrathoracic operation upon the chest wall in which ribs are resected from the pericardial region for the sole purpose of converting a bony resistant portion of the thoracic cage into a yielding flexible diaphragm.

The chief sign of adhesive mediastinal pericarditis is a perceptible rhythmic retraction of the intercostal spaces over the cardiac area, this retraction occurring during the heart systole. The systolic retraction is followed by a diastolic bulging. On the supposition that

this symptom indicates an effort on the part of the heart to obtain more flexibility of motion, Rudolph Brauer suggested this cariolysis to force the chest wall to yield to the heart's persistent tugging. Other symptoms and signs of the disease are diastolic collapse of the jugular veins, pulsus paradoxus, myocarditis, enlargement of the liver and ascites, all of these being associated with a restricted return of the venous blood to the right heart, accompanied by a weakening of the heart muscle in its effort to compensate for mechanical obstruction.

Many, and sometimes all, of these symptoms have been relieved by the operation of cardiolysis.

Technique of Operation.—A curved incision is made with its convexity downward and at the level of the fourth rib extending from the left sternal border to the anterior axillary line. A skin and muscle flap thus produced is reflected upward exposing the third, fourth and fifth ribs from the costochrondal junction for a distance outward of 8 to 9 cm. These three ribs are then resected subperiosteally. A difference of opinion exists regarding the advisability of removing the periosteum also. Its removal greatly increases the risk of tearing the parietal pleura, an accident which produces complications that may convert an otherwise safe procedure into a fatal one. Not that the resulting pneumothorax will instantly endanger life, but rather that the existence of pneumothorax generally leads to an effusion which in such cases readily becomes infected. For many months the subperiosteal resection provides the desired flexible area in the chest wall. All the relief to be expected will occur during this period to the same degree as when the periosteum also is removed. If the periosteum is left and re-formation of the bone or cartilage follows, the original purpose of the operation is destroyed. This re-formation of bone is a certain disadvantage. On the other hand, the extensive removal of periosteum may involve injury to the pleura, and no surgeon should attempt removal of the periosteum until he has previously performed, in a few cases at least, the operation by the subperiosteal resection method.

Variations in the above technique have been recommended, including the removal of costal cartilages and a portion of the sternum. It is doubtful if any further benefit is accomplished by so doing and here again pleural laceration is imminent. Certain enthusiasts recommend cardiolysis even when its leading sign, systolic retraction of the intercostal spaces, is absent. I question such conclusions.

Pericardial Effusions.—Accumulations of fluid in the pericardium are often associated with other serous exudates, especially those of the

pleura. These effusions are often tuberculous. Embarrassed heart action is essentially an indication for the removal of the fluid. Simple aspiration is sometimes sufficient for temporary relief. The needle should be introduced in the fourth left interspace 1½ in. from the left sternal border. Injury to the pleura is generally avoided because of the distended pericardium.

Hemorrhagic and purulent exudates are seldom relieved by aspiration. In such cases the fourth or fifth costal cartilage should be carefully excised, and an incision made to the pericardial sac, with evacuation of clots or pus, followed by drainage.

Diaphragm.—Surgery of the diaphragm is confined essentially to the repair of diaphragmatic herniæ, to the excisions of tumors involving the diaphragm, and to the transpleural approach to subdiaphragmatic viscera. As to the technique of such operations, certain general considerations may be mentioned, the details being determined by the nature, location and extent of the given lesion.

Intratracheal insufflation, or the use, if we choose, of differential pressure, should be instituted in all such cases. A long intercostal incision lying just above the diaphragmatic level should be employed, extending from the sternal border to the posterior axillary line. A rib-spreader is used. If the purpose of the operation cannot be accomplished through the pleural cavity, a subordinate high abdominal incision should be made, thus permitting access to the diaphragmatic lesion both from above and below.

THE BREAST

SECTION XXIII

LESIONS OF THE FEMALE BREAST

By

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Attention is called to the female breast by swelling, or tumor, pain, discharge from or retraction or ulceration of, the nipple; some change in an area of skin over the breast, or the palpation of some enlargement of the glands in the axilla.

When the patient seeks advice for one or more of these signs and symptoms, we may be somewhat influenced and helped in our interpretation of their significance by the following additional data: age, duration of symptoms; whether the symptoms had disappeared to reappear—especially tumor; whether the woman is married or single, whether pregnant or nursing her child, the number of children and the age of the youngest; whether there has been a history of trauma or mastitis; whether the menstruation is normal, changing, or the menopause established. The existence of pelvic irritating lesions should also be carefully investigated.

Breast Lesions.—We may have at birth, puberty and during pregnancy a diffuse enlargement of both breasts—a condition which can always be recognized clinically and should never be confused with a malignant tumor.

Mastitis as a rule is associated with lactation. It is always a diffuse lesion, never encapsulated, but may be circumscribed. We do observe mastitis in breasts which are not lactating. Then the mastitis is usually tubercular.

We do not know the etiology of chronic cystic mastitis. The affected area is never encapsulated but the large cysts which develop in a large per cent. of cases are individually encapsulated. The disease may, however, appear as a circumscribed tumor.

Cysts of the breast are galactoceles associated with lactation;

pyogenic and tuberculous abscesses; cysts in chronic cystic mastitis; papillomatous cysts, benign and malignant; and the true cancerous and sarcomatous cyst.

Encapsulated tumors are always benign. They are the cystic adenoma, the fibroadenoma and the intracanalicular myxoma. These tumors, however, may appear as circumscribed areas difficult to differentiate from adenocarcinoma.

Malignant tumors are never encapsulated, although they may be circumscribed. The types of malignant tumors are the adenocarcinoma, the scirrhous and medullary carcinoma, and the sarcoma.

We must recollect that cancer may begin in the breast during pregnancy, during lactation, and at any period of life after twenty-five.

Cancer may form in the scar residual after mastitis in which the original lump had remained quiescent for from 10 to 30 years.

Tumors may remain quiescent in the breast for many years. When growth suddenly appears, it is usually, but not always, associated with malignant change.

To increase the number of cures of cancer of the breast, we must give women the proper information which will influence them to seek an examination the moment after they feel a lump.

The most difficult problem falls upon the surgeon—to differentiate at the exploratory incision the various types of breast lesions and to decide then; whether to remove the lump, the breast, or to perform the complete operation for sarcoma or carcinoma.

Age.—Among 885 malignant tumors of the breast thirty-five or 3.9 per cent. have been under thirty years of age when the lump was first observed. In 10 cases the age of onset varied from 15 to 25 years. In six cases of cancer in which the age of onset was less than twenty-five, the tumors had been observed from 5 to 40 years, thus offering ample time for removal during the benign stage.

There remains but one positive case of cancer originating in a woman younger than twenty-five. This patient was 21 years of age and had observed the lump but a few months.

Of the four cases of sarcoma in which the patients were younger than twenty-five when the neoplasms were first discovered, in two the tumors were of 18 and 25 years' duration respectively. The remaining two cases are from outside sources, and I have been unable to confirm the data.

Therefore, when a patient with a lump in the breast is twenty-five or less, the chances of a malignant tumor are remote. After

twenty-five age does not help us, because cancer has been observed from twenty-six to seventy and over, as well as all types of benign tumors.

In the *newborn* we may observe enlargement of the breast; this is usually, if not always, bilateral, and associated with a discharge milky in character (*infantile hypertrophy*). This condition recovers spontaneously. On account of the discharge from the nipple, efforts to attain and maintain cleanliness should be great. After washing, the nipple should be protected with sterile cotton. Infections have taken place; abscesses and erysipelas have secondarily developed with mortality. My one observation recovered, and now, 17 years since, the breast has normally developed.

During *childhood* diseases of the breast are unusual and always benign. Tumors need not be removed unless they grow, or are associated with great pain.

At *puberty* benign conditions of the breast are often first observed. The attitude towards all lesions at this period should be conservative. Intense pain, rapidly growing tumor, huge enlargement of one or both breasts, are the only indications for operative interference. The object of such an operation is not to cure any hopeless disease, but to check and remove a lesion which, if left alone, would destroy the breast, or to relieve pain by the removal of a centrally situated tumor.

Unilateral Hypertrophy.—At, or shortly after, puberty the development of one breast may be more rapid than of the other. In six cases of my own observation the larger breast was not sufficiently large to excite any apprehension. The condition was really not unilateral hypertrophy, but unilateral development. In these six cases after a time the more slowly developing breast caught up with the other and symmetry was established. In one case the hypertrophy of the left breast was far out of proportion to normal, while the smaller breast was about normal for a girl two years after puberty. In this case, with the hope of checking the hypertrophy, a plastic resection of a quadrant was performed. It is now about 10 months since the operation, and there has been no further enlargement. We know from our experience with operations for benign tumors of the breast during and after puberty that there is no harm from such a plastic resection, but we have no evidence as yet that it will check unilateral hypertrophy.

Diffuse Bilateral Virginal Hypertrophy.—This condition has its onset at, or shortly after, puberty. At first there is observed the ordinary puberty hypertrophy. Later both breasts become so

much larger than normal that interest and anxiety are excited. In the literature the cases are usually observed from four to ten years after onset, and nothing has been done for this condition, except removal of one or both breasts. Apparently in this late stage nothing else offers any relief. If these cases are seen in the beginning of the trouble, menstrual disorders should be corrected, sexual disturbances controlled, and when the size of the breast has gone much beyond normal, plastic resection as noted above might be attempted.

Now and then unilateral hypertrophy may be due to the presence of a tumor in the center of the breast. In my only observation in-

Fig. 301.—Encapsulated aberrant fibroadenoma. Tumor larger than the breast. Breast to the median side.
Pathol. No. 7135.—Operation in 1906, excision of tumor; breast saved. Colored, female, aged 19, tumor seven months.

tense pain was the indication for operation. At the exploratory incision previous to the contemplated plastic resection, the central tumor was found and removed. The pain was relieved, and 10 years later this breast lactated normally.

At, or shortly after, puberty tumors in the region of the breast may develop, grow rapidly and, if left alone, become larger than the breast itself (Fig. 301). They are usually incorrectly diagnosed sarcoma, and the young patients are mutilated for life by the removal of a normal breast with a benign encapsulated tumor. *These are aberrant breast tumors*, and will be discussed again under fibroadenoma (page 598).

At what age should a single tumor of the female breast be removed?

In my own opinion, if the patient is under twenty, the tumor may be left alone, unless it exhibits growth, or is very annoying by pain. Between twenty and twenty-five there is some doubt as to what is best to do. On the whole, accumulated experience favors operation. After twenty-five there is no question—operate.

In many of the single and multiple tumors in girls under twenty-five which I have observed during the past 25 years the tumors have spontaneously disappeared. Young girls, if possible, should not be subjected during puberty to operations upon the breast. After twenty the chances of spontaneous disappearance grow less, and as the tumor certainly should be removed, if it does not disappear in a few years, why wait? There is no danger and no mutilation. The removal of these benign tumors protects the woman from growth of this tumor which may take place during a subsequent pregnancy or lactation at a time when an operation, even for a benign tumor, is more annoying than at an earlier period. There is also no doubt that it protects the woman from the possible development of a cancer in such a benign tumor.

In women after 25 years, their age can no longer be used as a factor either against operative interference, or in differential diagnosis. Although the relative proportion of benign and malignant diseases of the breast varies with the age of the patient, it is not sufficiently distinct to be helpful. If a surgeon uses age in his differential diagnosis after twenty-five, it will simply increase the number of his mistakes.

Duration of Tumor.—Theoretically, our patients should always see us at once, so that we would never be assisted in our differential diagnosis by the duration of the disease. When the woman waits, always at her own risk, the surgeon may be helped by the long duration of the disease without any definite change. But even here, there are too many exceptions to the rule, to allow one to rely much on the long duration of the disease. Our records show many cases of cancer in tumors which have been present 30 or more years. We know that when we operated the tumors were cancer. Our records may show when the clinical signs of cancer first developed, but we have no way of finding out when or why the malignant change took place. A tumor, then, of many years' duration which during this time has shown no growth and is quiescent today, may begin its malignant change tomorrow.

When the duration of the symptoms is helpful in the differential diagnosis, I will mention it later with the specific lesion under discussion.

The relative per cent. of benign and malignant lesions of the breast in our 1800 cases has changed gradually in the past 27 years, and very rapidly in the past three years. In the first 10 years of the observation the per cent. of benign lesions was 32, in the second period of 10 years it was 41, in the next seven years it was 54, but in the past three years 59 as compared with 47 in the preceding three years. This increasing proportion of the benign lesions of the breast has been associated with a shortening of the duration of the disease, and the latter has been due to the education of the profession and the public. Any clinic reporting today a larger per cent. of cancers of the breast suggests that this clinic is getting late cases.

The greatest changes which we have observed in the past few years in diseases of the breast are the duration of the disease, and its pathology.

ETIOLOGICAL FACTORS

Trauma.—Many breasts are bruised and after the contusion there may be ecchymosis and even palpable induration. All of these signs may disappear and nothing develop later. There are apparently but few records of such cases. I now have three which have been followed from the onset of the injury. In the oldest case it is three years since the trauma. This, like many other conditions of the breast, may be frequent, but we know little about it, because those who keep records are not consulted.

On the other hand, the number of breast lesions secondary to trauma is relatively small, but sufficiently large to impress one that trauma must be considered an etiological factor. All the cysts of the breast which I have seen in young women under twenty-five have followed a trauma. In sarcoma of the breast trauma is a much more frequent etiological factor than in carcinoma. Trauma may excite the growth of a pre-existing tumor, and this subsequent growth may be either benign or malignant. The history of a trauma, either positive or negative, is of no help in the differential diagnosis.

Breasts, however, which have been injured should be carefully watched. If the induration which immediately followed the contusion does not disappear in a few weeks, the area should be explored. If an area of induration or a tumor appears some days or weeks after

the trauma, in cases in which nothing was present immediately after the trauma, exploratory operation is indicated at once.

Infection.—In the absence of pregnancy and lactation, the breast is especially immune to metastatic involvement in general or local infection, yet this may occur, as will be discussed under *mastitis*. When we have a local infection on the body or on the upper extremity, the breast now and then is secondarily involved. When the patient gives a history of tuberculous glands of the neck which have healed; when scars from a recent suppuration in the axilla are seen; when sinuses are found, and there has occurred a more recent enlargement of the breast, the chances are that we are dealing with tuberculosis. Without such a history such a breast with its present induration and retracted nipple would have to be considered the seat of a malignant lesion.

The history, or demonstration, of a portal of infection near the infected breast may now and then urge the surgeon to explore rather than to perform the complete cancer operation for a breast condition which is clinically malignant. But these are unusual conditions and can only be fully considered in a monograph or case reports.

Pregnancy.—If a lump is felt in the breast of a pregnant woman and the patient is over twenty-five, it should be explored at once; during pregnancy as well as in the lactation, cancer disseminates with greater rapidity. At exploration, a benign tumor may be exposed (Fig. 307). All lesions of the breast during pregnancy are unusual. Benign and malignant tumors are about equally divided. Among the cancers in our records there is one blood-cyst and no sarcoma. Among the benign lesions tumors predominate. Mastitis is very rare and when present is usually tuberculous.

When a woman knows that she had the lump in her breast before she was pregnant, immediate operation is not so essential, but it is far better to remove the lump before the birth of the child. I have usually selected the period between the third and the fifth month. The tumor should be removed, because during lactation it is more apt to give trouble. It seems safer for the child to remove the breast tumor during pregnancy than during nursing.

Diffuse Bilateral Gravidity Hypertrophy.—The bilateral hypertrophy observed in virgins after puberty may be observed in the breasts during pregnancy. As far as I can learn from the literature, it is a rare condition. If these breasts produce milk, and the child nurses, the condition as a rule spontaneously recovers. If, however,

there is no secretion of milk, spontaneous recovery rarely, if ever, takes place.

Lactation.—The predominant lesion of the lactating breast is mastitis. The portal of entrance of the infection is through the injured nipple. The suckling child is apt to injure the nipple within the first few months. Lactation mastitis is most frequent within the first month, and very rarely observed after the fourth month.

FIG. 302.—Galactocelė—a single cyst containing milky fluid. The breast contains dilated ducts with milky fluid.

Pathol. No. 10948.—1910, complete operation for cancer on account of retracted nipple and red, adherent skin.

White, female, aged 40; a mastitis in this breast many years ago leaving retracted nipple; at the time of the operation patient was nursing child two years of age. Tumor observed three months. Rapid growth; painful and tender. The changes in the skin were probably due to an infection of the galactocele. The microscopic study shows chronic mastitis (see Fig. 314) and dilated ducts (see Fig. 318) and some areas of lactation hypertrophy (see Fig. 323).

A lump, or a "cake," or an induration of the breast in the first four months of lactation may at first be looked upon as mastitis. We should expect in such a palpable area resolution (spontaneous disappearance), or the formation of a definite abscess (relieved by incision). If one of these two things does not take place within two weeks, one should be suspicious of malignancy. The area should be

explored. The chronic mastitis abscess (Fig. 303)* and galactocele (Fig. 302) must be distinguished in the gross from the cancer cyst (Fig. 305). Tuberculosis (Fig. 304) may be recognized by the abscess.† The non-suppurating chronic mastitis is most difficult to differentiate from cancer. The benign tumor will be found encapsulated (Fig. 306). The dilemma here will come in the frozen section (Fig. 307).

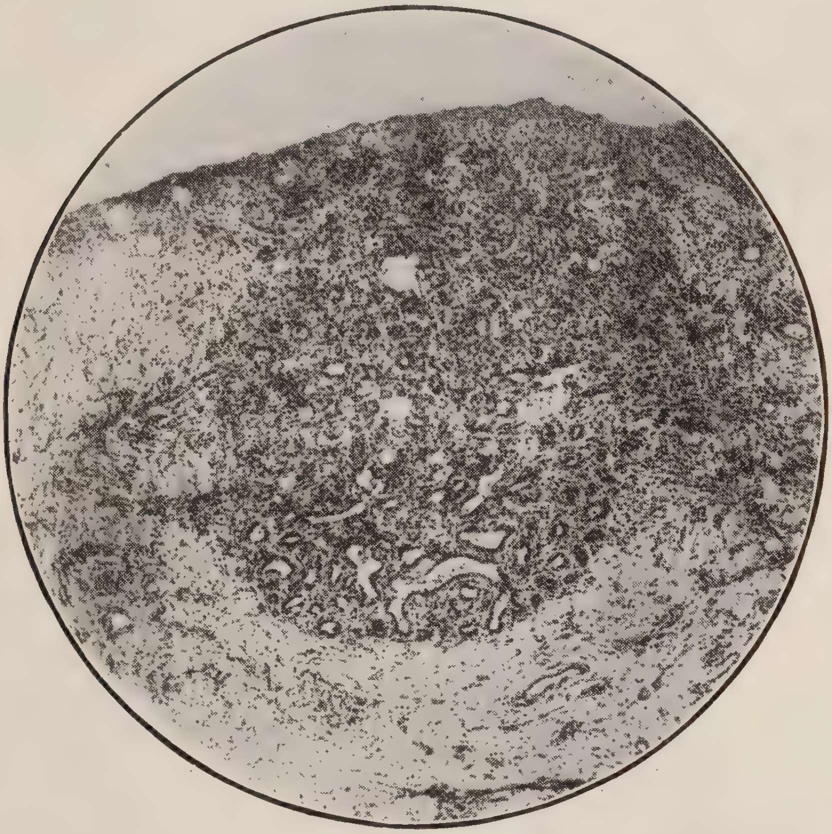

FIG. 303.—Chronic mastitis in a lactating breast, from the wall of a chronic lactation mastitis abscess.

Pathol. No. 228.—1893, excision of cyst; later complete operation for cancer, on account of the microscopic picture shown here. 1916, 23 years, well.

White, female, aged 29; nursing child four months old; tumor two months. Clinically and gross a chronic abscess; surrounding breast shows normal lactation with a zone of mastitis adjacent to abscess cavity.

In lactation the nipple should always be protected. When the cake appears massage is not sufficiently beneficial in mastitis to justify its employment while it would be distinctly dangerous if the lesion were malignant. Cleansing and protection of the infected nipple are the most important things in the treatment. Bier's hyperemia, ice, or the hot-water bag may be employed. My personal experience is too limited to speak authoritatively. I have confined my treatment to the nipple and to ice and have been surprised at the large

* All these photographs were taken by Mr. Herman Schapiro.

† Tubercular mastitis without abscess shows no caseation. It resembles lactation mastitis without abscess. Both suggest infiltrating carcinoma. Both in the gross and the frozen section.

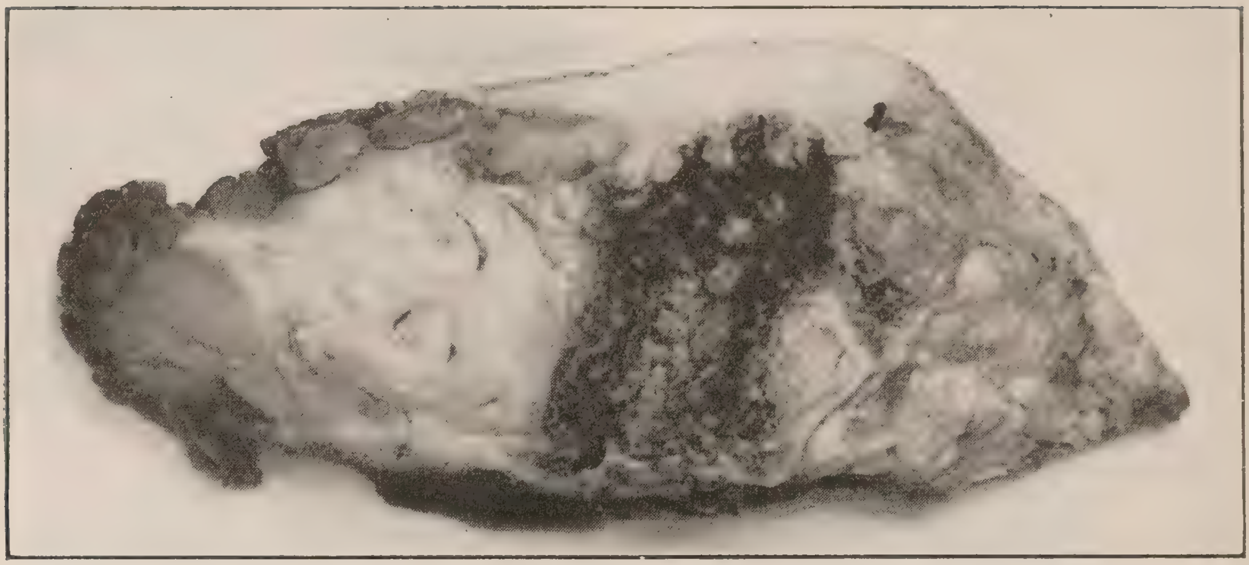

FIG. 304.—Tuberculous abscess of breast. Cavity lined by tuberculous granulation tissue.
Pathol. No. 19066.—Operation in 1916, complete excision of the breast.

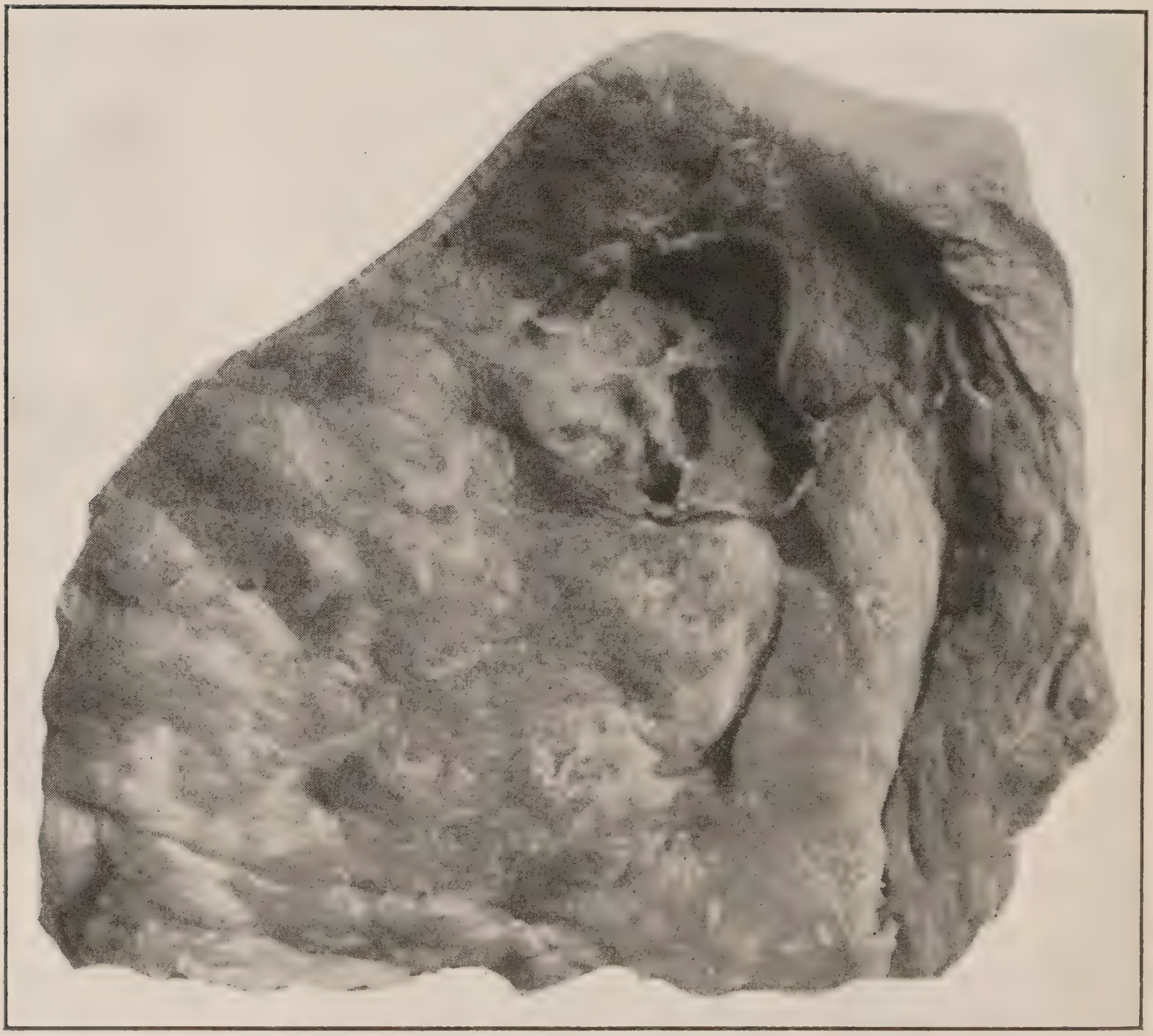

FIG. 305.—Cancer cyst in senile breast.
Pathol. No. 7665.—Complete operation for cancer.

number of cases of spontaneous disappearance. If ice should give discomfort—do nothing. On the first signs of pus—incise.

For abnormalities in lactation, especially the scanty secretion of milk, I shall take no space.

Mastitis.—*The history of "caking" of the breast* during lactation, of a definite mastitis which disappeared spontaneously, or of an abscess which was incised or ruptured spontaneously, must be considered in the differential diagnosis.

The history of a lump appearing during lactation, or remaining after lactation is suggestive of a *galactocele* (Fig. 302). At the present time our records are meager in regard to this interesting breast lesion.

Malignant tumors of the breast have apparently no relation to a mastitis which disappears spontaneously, or forms an abscess which heals. However, if the induration in the area of the mastitis, whether

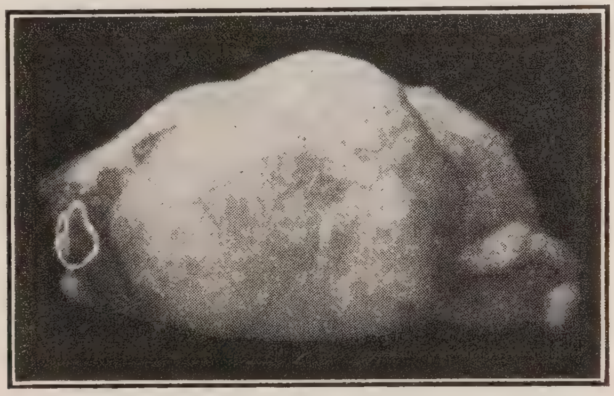

FIG. 306.—Encapsulated fibroadenoma removed with a zone of breast; stroma in excess. Pathol. No. 9340.—Operation in 1908. White, female, aged 19; tumor four weeks. In 1916, eight years, well.

there has been an abscess or not, does not disappear, cancer may develop in this area (Fig. 308).

These two facts—the occurrence of galactocele and cancer in old scars after mastitis—represent additional evidence to emphasize the dictum that no lump in the breast can be considered innocent, and except in girls under twenty-five and during lactation, every lump in the breast should immediately be explored.

In the lactating breast, in view of the common occurrence of mastitis, we are justified in watching the indurated area for a short period, but in the absence of complete resolution or pus formation, the doubtful area should be explored. When there are indurated scars after a mastitis, these should be excised with a good margin of healthy breast.

Mastitis, except during lactation, is a rare disease, and one should never make a clinical diagnosis, but should explore the area.

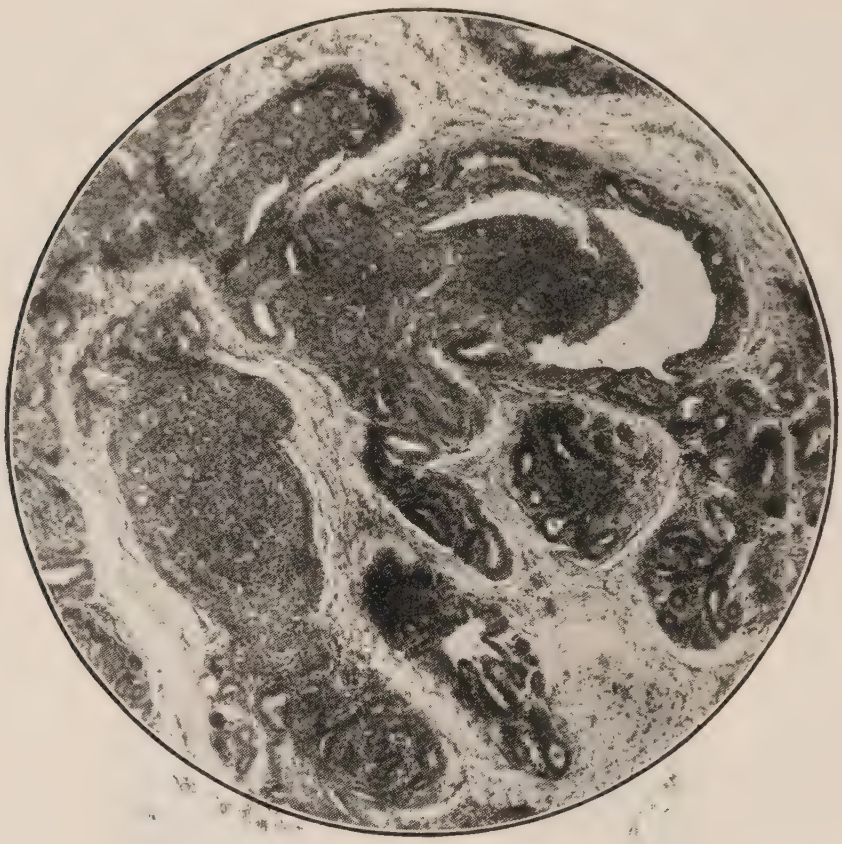

FIG. 307.—Lactation hypertrophy in an encapsulated fibroadenoma.

Pathol. No. 15518.—Operation in 1914, excision of tumor and zone of breast. White, female, aged 20; tumor three months; patient pregnant two months. 1916, two years, well. Pregnancy and lactation not disturbed by operation.

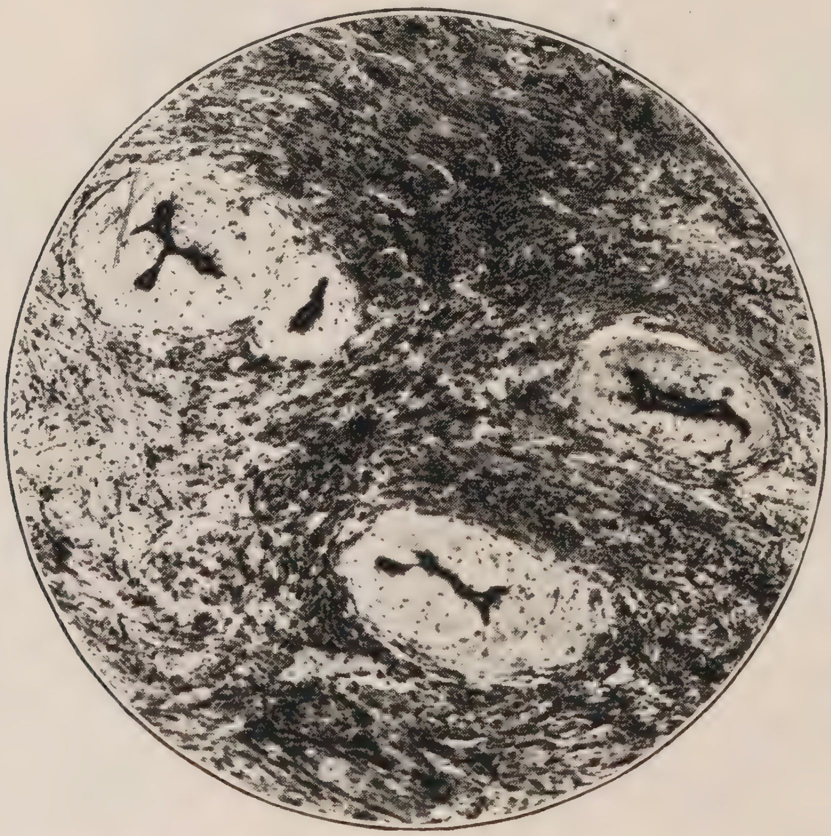

FIG. 308.—Scirrhous carcinoma developing in the scar residual from chronic mastitic. The ducts with their thickened walls preserved.

Mastitis and Lactation.—*Lactation may persist* if the child is allowed to nurse, in spite of the presence of single or multiple abscesses. Nor do the latter necessarily interfere with lactation after a subsequent pregnancy.

Menstruation.—The relation of breast lesions to diseases of the pelvic organs needs much more data before it can be defined. We know that with pregnancy the breast immediately undergoes a parenchymatous hypertrophy. The fully developed secretion of milk, to be maintained, is apparently dependent upon irritation of the nipple. Lactation ceases and the breasts return to normal when the child ceases to nurse.

There is some evidence to suggest that there may be parenchymatous changes in the breast associated with pelvic conditions other than pregnancy. The lesion of the breast called chronic cystic mastitis is most frequent during the period called the menopause.

The relation, however, between pelvic lesions, the menstrual period, and breast lesions is not sufficiently well established to be helpful in the differential diagnosis.

Menopause.—It is quite true that, except for cysts and chronic cystic mastitis, benign tumors are rare after the menopause, but the number of the former (cysts) is sufficiently large not to justify the complete operation for cancer of the breast in women after the menopause without exploratory incision.

Children.—Most careful studies have been made on the relation of the different forms of breast lesions in unmarried women, in married women who have borne no children, in married women who have borne children, and the character of the lactation in the latter. These data are rarely, if ever, helpful in the differential diagnosis, and although of interest to record, they must not be allowed to weigh much, if at all, in the differentiation between a benign and a malignant tumor. It is true that chronic cystic mastitis is much more frequent in the breast which has never lactated, whether there had been pregnancy, or not. When, therefore, you see a woman reaching the menopause, whose breasts have never lactated, who comes to you because of pain in the breast and the feeling of an indefinite lump, and you find in this and in the other breast other lumps just as indefinite as the one the patient has felt, you probably will be safe in diagnosing bilateral chronic cystic mastitis, for which operation is not indicated at this time. I will consider this point again, as many breasts now are being sacrificed for certain stages of this disease.

HISTORICAL DATA

Up to the present time an intensive study of the data thus briefly discussed has shown that with rare exceptions they cannot be depended upon for differential diagnosis. Perhaps future studies may find some diagnostic points. I am confident that in many cases precious time has been lost by allowing data of this kind to influence the diagnosis and the decision as to operative intervention. I have not mentioned the family history of cancer or tuberculosis and purposely so, because its presence or absence should have no influence on the surgeon's conclusions.

SYMPTOMS OF ONSET

I have called attention to these in the first paragraph. The most frequent symptom is the palpation of a tumor, and if we could educate women to pay immediate attention to this one message, the number of deaths from cancer of the breast would be immediately diminished. Confusion has been caused in the minds of women by other possible symptoms, especially pain. The woman usually waits for pain, and in the past, when a physician was asked to see the lump, he usually waited for the so-called clinical signs of cancer—retracted nipple, adherent skin, ulceration; and he thought much about the presence or absence of palpable glands in the axilla.

The majority of women are warned by a lump, and that warning should be enough. If the physician can feel a lump, it is fortunate for the patient if nothing else can be made out on examination.

Pain.—Pain is neither a sign of cancer, nor necessarily of any dangerous lesion in the breast. Pain in one or both breasts is not uncommon in women just before the menstrual period and disappears after the beginning of the flow. As tingling of the breasts may be the first suggestion of pregnancy, so pain in the breast may be the first warning of the coming menstrual period. Undoubtedly many women experience these discomforts and say nothing about them.

Up until 1910 I have records of but five patients who came under observation for pain only; the duration of this pain had varied from three weeks to four years. In none of these cases has any disease of the breast developed. Since 1910 there are records of 12 cases; the duration of the pain has varied from four days to two years.

The most common factor in all of these cases is that the women are usually approaching the menopause, and naturally one thinks of

chronic cystic mastitis. We know that at autopsy small cysts and dilated ducts are present in at least 25 per cent. of the breasts of all women over 40 years of age.

The next most frequent historical fact is the fear of cancer. These patients have had some near relative or friend die of cancer, and then experienced pain in the breast. In our seventeen patients there are but three under 30 years of age; the youngest was twenty-three.

The thing which should interest us most is whether pain in the breast is a forerunner of some disease and if so, of what form.

In the great majority of cases, when pain is the first symptom and tumor the second, the tumor is benign.

Nevertheless in a record of almost 1800 cases there is not a single variety of benign or malignant condition of the breast in which, in some cases, pain had not been the first symptom observed.

However, if nothing is found on palpation, pain is not an indication for operation. Of course, such patients should be carefully watched. Future intensive investigation may disclose a few instances in which pain alone may be relied upon as an indication for the removal of the breast.

Discharge of Blood from the Nipple.—There is a prevailing view that a bloody discharge from the nipple means cancer, and that the complete operation for cancer should be performed. This conclusion is apparently based on records different from my own, or on incorrect observations.

My experience shows that *if there is no other sign or symptom*, except discharge of blood from the nipple, there is no more indication for operation than in the presence of pain alone. I am hopeful, however, to be able some day to recognize the few cases in which discharge from the nipple can be properly interpreted as an indication for the removal of the breast.

In 876 cases of cancer of the breast discharge from the nipple has been the first symptom in but 16 cases (less than 2 per cent.). In the majority of these the tumor was felt at the same time or within a few days after the discharge was noted. In a few cases the interval was months, in two cases only was the interval a year.

Among 716 cases of benign tumors of the breast discharge from the nipple has been the symptom of onset in twenty-four (slightly over 3 per cent.). In the majority of these cases the tumor proved to be an intracystic papilloma. In fact, it is a question whether

such an intracystic papilloma was not present in every case subjected to operation.

In nine cases of discharge of blood from the nipple in which nothing else could be made out, no operation was performed, and no tumor developed. In this group there are four cases in which the interval is 11 years or more; the others are more recent—four years or less. The longest duration of a bloody discharge without the development of a tumor was three years.

We have, therefore, no evidence that discharge from the nipple is an indication of malignant disease, but cases of this kind should be carefully watched, and the patient should be instructed how to keep the nipple scrupulously clean.

Retraction of the Nipple.—The sudden appearance of retraction of the nipple is a sign of entirely different significance from that of discharge of blood from the nipple. It is usually the warning of malignant disease of the breast. It may be present, but very rarely, in benign conditions. If one can establish that the retraction of the nipple is really of recent appearance and is not a congenital, or old affair from some former lactation mastitis, it should be looked upon as indicating a malignant tumor in the breast and the entire breast removed, or the complete operation for cancer done.

Retraction of the nipple may be a congenital condition, but this type of depressed nipple as a rule is different from the acquired retraction. Retraction of the nipple may take place after a mastitis with or without abscess formation, and now and then, when the child is suddenly taken from the breast, one or both nipples may pull in without evidence of mastitis.

In a few instances with distinctly benign lesions retraction of the nipple has been the first symptom observed, chiefly in chronic cystic mastitis.

At the present time it is my opinion that it is safer to look upon this type of retraction of the nipple as a definite sign of cancer. If nothing else can be made out, it is my practice to completely remove the breast with the pectoral fascia to the axilla; to clamp the axilla and cut it off with the cautery; then make serial sections into the breast; if cancer is found, proceed with the axillary operation; if not, remove the axillary tissue beyond the clamp.

If cancer is not found, a condition of the breast is usually present best treated by complete removal of the breast.

I have been surprised at the attitude of many experienced clin-

icians and surgeons towards this retraction of the nipple when it has been the only sign present. Precious time has been lost waiting for the appearance of the tumor. As a rule in these cases the cancer is in the nipple zone and difficult to recognize by palpation, or the women have large, fat breasts, and the little scirrhus is too deeply situated to be recognized.

Pain and discharge from the nipple are messages, but require no answer. Retraction of the nipple is a message which should receive immediate attention.

Ulceration of the Nipple (Paget's Disease).—Years ago Paget described a number of cases of cancer of the breast associated with ulceration of the nipple. In this special group, Paget states, the ulceration of the nipple has begun one or more years before the patient had felt the lump in the breast. As far as I know, there are no recorded cures, when the operation has been performed in the Paget stage.

The sore nipples during lactation require great care and give anxiety chiefly in relation to mastitis.

There may also be a syphilitic ulceration of the nipple in the nursing mother, but other symptoms on the part of mother and child should excite suspicion, and the Wassermann test will do the rest.

Any irritation, or eczema, or ulceration about the nipple and areola should receive immediate attention. In some cases copious use of soap and water will cure the disease. In others there will be a positive Wassermann. When cleanliness fails to relieve and the blood examination is negative, I am confident that it will be safer to look upon this lesion of the nipple just as we have decided to regard retraction of the nipple—as a sign of cancer. Nothing can be gained by excising a piece for diagnosis, or completely excising the nipple zone. The breast should be removed or the complete operation for cancer performed. Not all of these cases are cancer, but I am unable, from the available data, to tell how to differentiate the benign from the malignant. I am confident that the mutilation should be considered less, than the greater risk of any conservative operation.

Subcutaneous Fat.—In the normal breast the nipple, the areola and the skin are freely movable over the deeper structures, and there is always a zone of subcutaneous fat between the skin and the breast, except beneath the nipple. When one can palpate a small tumor, the demonstration of absence of subcutaneous fat between the skin and the tumor is a sign of malignancy. In large tumors it is possible to have an atrophy of this fat from pressure in lesions distinctly benign.

Atrophy of the subcutaneous fat may also be observed in pyogenic and tuberculous mastitis.

The demonstration of atrophy of the subcutaneous fat is rather an expert procedure; it is one of the earliest signs of cancer.

In virginal and gravidity bilateral hypertrophy the parenchyma and stroma of the hyperplastic breast tissue may replace the subcutaneous fat and bring the breast tissue immediately beneath the skin. But in this disease it is not a sign of malignancy.

Skin.—Only once have I observed discreet skin metastasis in a breast tumor otherwise apparently benign, and in this case the two

Fig. 309.—Bulging of tumor. No dimpling of skin over a simple cyst in chronic cystic mastitis.

Path. No. 8579.—White, female, aged 52. Tumor one year. Operation, 1907, excision of cyst and zone of breast. 1916, nine years, well.

little nodules were present in the zone of skin directly over the breast tumor. There is no way to distinguish a single metastatic skin nodule from the common fibroma of the skin. Fortunately the latter is very rare in the breast area, but I have observed two cases of benign breast tumors in which there were also present single, shot-like skin nodules which were fibromas. This possibility should be borne in mind,

and one should not make a diagnosis of malignant tumor of the breast because of a single skin nodule.

The changes in the skin which are rarely associated with benign tumors are *dimpling* and *slight fixation*. The dimpling is brought out by pushing the breast with the palpable tumor with both hands (Figs. 309 and 310). Fixation is elicited by picking up a bit of skin over the tumor.

These two early signs of cancer have now and then been observed in benign lesions, especially simple cysts.

FIG. 310.—Dimpling of the skin over the bulging tumor. Small infiltrating scirrhus. Path. No. 7973.—White, female, aged 54. Tumor six weeks, pain 10 days. Complete operation, 1907. No metastasis to axilla. 1916, nine years, well.

Redness and definite adhesion of the skin to the tumor are observed in pyogenic and tuberculous mastitis, and in infected cysts (which are very rare). In the vast majority of cases they are signs of cancer. Very large benign tumors (intracanalicular myxoma) may by pressure produce ulceration of the skin. With this exception ulceration is an almost positive sign of cancer.

The formation of a sinus or sinuses is very unusual in a malignant tumor of the breast. It is very common in tuberculosis after the sixth month. The early formation of a sinus favors a pyogenic abscess. This latter should heal rapidly, while the sinus from a tuberculous focus rarely heals.

When a malignant breast tumor becomes infected, forms an abscess, becomes adherent to the skin, ruptures and forms a sinus, the differential diagnosis from mastitis, pyogenic or tuberculous, is practically impossible clinically. Although it is very rare in malignant disease, the evidence seems to indicate that, in cases of this kind, it is a safer procedure to operate for cancer. In most of these cases the breast must be removed in any event. In a few instances one with a large experience, having recognized the benign character of the lesion, may, with comparative safety, perform a conservative operation.

In a few instances a local infection in the skin over the breast may involve the deeper tissues and produce a clinical picture suggesting malignant disease. Here a careful history will be helpful.

The later changes in the skin associated with fully developed cancer should give rise to no difficulty, and although now and then these may be associated with mastitis, it is always the safer procedure to operate for cancer. These more definite skin changes are the so-called "pig skin," marked induration, multiple dimpling, superficial ulceration, reddening, dilatation of veins.

Œdema of the skin and subcutaneous tissue over the breast is usually a sign not only of cancer, but of hopeless cancer. I have, however, observed it twice in benign conditions of the breast. In both instances the breasts were large and pendulous, the induration of the breast and œdema of the skin and fat had followed a trauma and had persisted.

Axilla.—Too much importance has been placed upon the presence or absence of palpable nodules in the axilla, and so far the recent teaching has been unable to overcome the older. In benign lesions of the breast, glands are frequently palpable; in cancer of the breast with metastasis to the glands in the axilla, one may be unable to palpate glands.

In my entire experience I have only observed one case in which the palpation of large and adherent glands in the axilla led to a diagnosis of malignancy even in the absence of any palpable lump in the breast. After the complete operation a small schirrous cancer was found in the breast. This woman, however, had a large, fatty breast.

In a small number of cases of cancer of the breast the patient's attention to the disease has been attracted by the nodules in the axilla, and the tumor of the breast was not felt until later. But this, of course, does not exclude the presence of the breast tumor at that time.

When one feels a palpable mass or a number of enlarged glands in

the axilla and palpation fails to reveal any trouble in either breast, there should first be a blood examination to exclude leukemia or syphilis. Having excluded these, the probabilities are that one is dealing with a primary lesion within the axillary area. The number of such cases is small. We must first bear in mind aberrant breast tissue. Tumors of this kind feel like lipomas. I will discuss them later. Then there are a few examples of hypertrophy and infection of the axillary sweat glands. The most common benign tumors in the axilla are lipoma and fibromyxoma of nerve sheaths.

We must also bear in mind that the glands may be enlarged from pyogenic or tuberculous infection through a portal of entrance, situated at a distance, but which has healed, and the patient may have forgotten the incident. (Healed wounds of fingers.)

Sarcoma of glands, nerve sheaths and fascia are possible.

In the surgical attack on axillary masses without breast involvement the mistake is usually made of performing an incomplete operation on the clinical diagnosis of a benign lesion. If these cases are carefully considered, one should be able to recognize those in which a complete axillary dissection offers the patient the best opportunity of a cure, and in my experience, whenever such an axillary dissection is indicated, it is best to perform the so-called complete operation for cancer of the breast.

Supraclavicular Glands.—The involvement of these glands is a late occurrence in cancer of the breast. The decision as to when to explore the neck depends less upon palpation before operation. than upon the findings within the axilla at operation. This will be discussed under operation.

Other Breast.—Both breasts should always be carefully palpated. The finding in the other breast of single or multiple tumors is a factor in favor of benignity, which will be discussed again under tumor.

We often now see patients with a lesion of one breast, and a history of some condition in, or operation on, the other breast. For example, there may be a history of a disappearing tumor, discharge from the nipple, or pain. This is suggestive that we are dealing with a bilateral lesion which in the majority of cases is benign, usually a simple cyst or an intracystic papilloma.

When there is a history of removal of a tumor from the other breast and no evidence of recurrence, we have evidence that this tumor at least was benign. But unless we have absolute proof of the nature of this tumor, we are not helped. Should we know positively that the removed

tumor was a cyst or an intracanalicular myxoma, this evidence would favor a benign tumor in the breast under examination.

Among almost 200 cases of simple cysts of the breast we have seen cancer of the remaining breast once only. This indicates that if a patient has a cyst in one breast and then a tumor develops in the other breast, the chances are that the second tumor is also a cyst. The same is also true of intracanalicular myxoma.

With these two exceptions the knowledge of a previous tumor of the other breast is not helpful, except when we know that the first tumor removed was a cancer. This is very suggestive that the present tumor is also malignant.

Our observations show that the longer our patients live after an operation for cancer of one breast, the greater the probability of cancer of the other breast. As yet we have not sufficient evidence to prognosticate this occurrence and to justify the removal of the other breast as a protective measure.

Bilateral diseases of the breast will be discussed under multiple tumors.

Other Organs.—*I have no evidence that would be helpful* in the differential diagnosis of breast tumors by the finding of lesions elsewhere. In older literature there is much stress laid upon cases in which the symptoms of metastasis were the first signs of cancer of the breast, especially fracture of the neck of the femur and paralysis of the lower limbs. But apparently in these cases the breast lesion was overlooked by patient and physician in a way not likely to occur today. The only fact that has impressed me in a long observation is that we rarely see cancer of the breast in women with marked tuberculosis of the lungs, while in our cases of tuberculosis of the breast lung involvement, if present, is slight.

Vague pains in the chest, in bones and joints, which as a rule are the first signs suggesting metastasis after operation, cannot be interpreted before operation as an indication of metastasis. Again and again I have observed them before operation in patients who have remained well years after the complete operation for cancer.

Patients with lesions of the breast should receive a most careful general investigation, but up to the present time it has not been especially helpful in the exact diagnosis of the condition in the breast.

I am now investigating the relation of chronic cystic mastitis to pelvic lesions, but as yet have obtained no definite data.

As a rule our patients with breast tumors are good operative risks.

One should always think of the ribs below the breast as the possible focus of the breast lesion. I have seen this occur but twice. Both were instances of post-typhoid perichondritis in which the pus had infiltrated the breast. In one of these at exploration we found an abscess, in the other an encapsulated bone sequestrum.

Single Tumor.—In the vast majority of cases the patient first observes a single tumor, and if she seeks advice at once, this is all that will be found at examination.

I have learned that, when a woman comes under observation complaining of a breast lesion, it is a safer plan to at first take no history and caution the patient not to tell you which breast is involved. In the past two years this plan has been especially useful because of the greater number of women who are seeking advice early for vague pain, indefinite lumps and slight weeping from one or both nipples. If after examining both breasts most carefully you can feel no distinct lump, or if the indistinct area which you feel is not the one the patient felt, the chances are there is no definite tumor. When a patient tells even an experienced surgeon that she has a lump in the upper and outer quadrant of the right breast, there is a tendency for him to feel this lump.

The breasts of many women are lumpy. This is most marked just before and in the beginning of menstruation in all women. In unmarried girls palpation produces congestion and the suspicion of a lump, but in these cases the age under twenty-five helps to exclude cancer. Now and then, however, such breasts are explored and no tumor is found. In older women who have nursed children and in younger women who have not, lumpy breasts are a common finding, especially toward the menopause.

Now that women are seeking advice so early, we should be particularly anxious not to overlook a single tumor. But at the same time we do not wish to subject them to unnecessary operation.

We must also bear in mind that a patient may have felt a tumor, and the previous examiner may also have been correct, but when you examine the patient there is no tumor. You may also feel the tumor at your first examination and fail to find it at the next. This is the *disappearing tumor*—a simple or papillomatous cyst, and its disappearance is almost as good a cure as its removal by operation.

The demonstration of a definite single tumor is an indication for immediate operation when the patient is over 25 years of age, and with rare exceptions the operation is also indicated in women

over twenty. The function of a breast is not injured by the removal of a single tumor, and, if this tumor is benign, the patient is protected by the removal of a precancerous lesion.

The object, however, of operating upon a single tumor is not so much to remove a benign lesion as to expose and recognize a possible cancer in a period when the chances of a permanent cure are best.

Disappearing Tumors.—I have records of nine cases of tumors which have disappeared when felt after a most careful examination. The age of these patients was under thirty in three, in four it was between thirty and forty, and in one forty-five. So far in this group no other tumors have appeared in the same or the other breast. In four cases it is now from 7 to 22 years since the first observation.

Among 174 cases of simple cysts in chronic cystic mastitis 14 cases gave a history of a disappearing tumor before they came under observation. Among fifty-nine of these 174 cases, in which the cystic tumor only was removed, six have observed a disappearing tumor since operation.

Among 50 cases of chronic cystic mastitis without large cysts found at operation only two gave a history of a disappearing tumor.

Apparently the disappearing tumor is a simple cyst. When a simple cyst has been removed from the breast and a second tumor appears later in this or in the other breast, there is great probability that this is another cyst. In my experience it has been cancer in only one of the 60 cases when both breasts were saved, and one out of 100 cases when one breast remained.

Among 43 patients whose removed tumor proved to be a benign intracystic papilloma there is not a single example of a disappearing tumor in the previous history, and in only one case was it observed after operation.

Among 800 or more malignant tumors of the breast we have recorded the observation of a disappearing tumor in only three cases.

The history, therefore, of a disappearing tumor is very suggestive of chronic cystic mastitis with cyst formation. But I would not allow this to influence me against exploring the second tumor when it appears, because there is a possibility, though remote, that it may be malignant.

Multiple Tumors.—*The correct presentation of the problem here* is much more difficult than with the single tumor. The number of cases is relatively small.

The most significant fact is that among the cancers of the breast

the majority of the patients presented themselves with a single tumor in one breast.

In a few instances there were multiple tumors in one or both breasts. These observations are sufficient to show that one of multiple tumors in one or both breasts may become malignant.

The most common multiple tumors of the breast are those which have the least tendency to become malignant—the simple cyst and the intracanalicular myxoma.

If one palpates distinctly more than one tumor in a breast, or tumors in both breasts, at least one tumor in each breast should be explored. One should select the tumor of longest duration, or the largest, or the one most suspicious, on palpation, of possible malignancy. If the tumor proves to be a simple cyst, or an intracanalicular myxoma, or a lipoma, I think, we are justified in removing the tumors and saving the breast, especially in younger women. We have a number of examples of the removal of multiple intracanalicular myxomas from one or both breasts, but in the presence of multiple simple cysts, the majority of surgeons remove the entire breast. I have records of 10 cases only in which multiple simple cysts were removed from one or both breasts. These patients have been as uniformly relieved as the 108 in which one or both breasts were completely excised.

CLINICALLY BENIGN TUMORS

When the surgeon feels unable to make the diagnosis of malignancy the breast lesion for practical purposes is clinically benign (Fig. 309). There is no necessity for a border-line group of clinically doubtful tumors, because to one who knows there is always an element of uncertainty.

Some surgeons from their experience may be better able to elicit slight fixation of the nipple, atrophy of the subcutaneous fat, dimpling or slight fixation of the skin (Fig. 310), when the less experienced one might overlook these. Again, experience is helpful in the interpretation of the palpation of the tumor and the surrounding tissue.

No surgeon should, however, feel too sure of his clinical diagnosis. If there are definite clinical signs largely favoring malignancy, the operation for cancer should be performed without an exploratory incision. The number of mistakes in performing this for a benign lesion will be relatively very small. But, on the other hand, if all the signs of a malignant tumor are absent, it is not justifiable to proceed with the

complete operation for cancer without excluding a benign tumor by an exploratory incision.

The per cent. of benign tumors is steadily increasing, in my observation from 32 to 59 per cent., and if every woman sought advice the moment she felt a lump in the breast the proportion of benign lesions would be still greater.

The surgeon today, therefore, must prepare himself to recognize breast lesions by their naked-eye appearance, with or without the aid of a frozen section, and this differential diagnosis is more difficult than that which confronted the older surgeons in the clinical differentiation. Then women waited as a rule until each lesion had differentiated itself. Now women are coming when there is no known clinical differentiation, and recently the number of cases, in which there is a great dilemma at the exploratory operation and in the frozen section, is increasing.

Personally I have seen in the past two years more non-encapsulated zones of the breast tissue which at first sight felt and looked like cancer at the exploratory incision, which were very suspicious of cancer in the frozen section, but which I believe are not cancer.

Until recently we explored 10 per cent. of lumps which turned out to be cancer; now we are exploring as many as 40 and 50 per cent. According to my records the mistakes of performing the complete operation for cancer for a benign lesion were until a few years ago about 10 per cent. In the hands of the same group of surgeons today it has reached almost 15 per cent.

The mistakes are not made with scirrhus or medullary cancer, but with local areas of mastitis, chronic cystitis mastitis, papillomatous cysts, and adenomas. All of these benign lesions are on the increase, while the fully developed medullary and schirrhous carcinoma are on the decrease.

When the benign lump is explored, it is best for the patient to treat the lesion as malignant, unless one is absolutely certain that it is benign. Mutilation is nothing as compared with the fatality of an incomplete operation for cancer.

To recapitulate: When the palpable lump is associated with retraction of the nipple, dimpling or adherent skin, or a pretty definite infiltration of the surrounding breast, that is, the usual signs of cancer, it is by all means best for the patient to perform the complete operation for cancer.

When at the exploratory incision the naked-eye appearance and the

frozen section, leave you in doubt what to do, the complete operation for cancer is best for the patient.

One should not mistake medullary or scirrhous carcinoma for any benign lump.

Until a few years ago my evidence indicated that if you removed a cancer of the breast as the original lump only and then, later, after microscopic study, performed the complete operation for cancer, the chances of a cure were reduced from about 80 to 10 per cent.

However, in recent years a large number of border-line tumors have been sent to the laboratory for diagnosis—cases in which the tumor only had been removed. In this group there were no fully developed cancers. In some cases the laboratory diagnosis was benign, and no further operation was advised. In others, on account of suspicion it was advised to remove the breast. In still others the diagnosis of early adenocarcinoma was made, and the complete operation for cancer was suggested.

The remarkable fact about this group is that in spite of what diagnosis we made and what operation we advised, there is not a single death from cancer, nor a single recurrence.

This group of about sixty cases has been submitted to many pathologists throughout the country. In not a single case is there a uniform agreement as to the diagnosis, or what should have been done.

For example, some of the encapsulated tumors which we had considered benign cystic adenomas or fibroadenomas, other pathologists have diagnosed cancer. In this group of cases the tumors only were removed. On the other hand, in cases which were considered by us early adenocarcinoma and in which we advised the complete operation for cancer, the consulting pathologists have viewed the breast lesion as benign.

This introduction is absolutely essential to what follows.

The diagnoses are my own, but it is important for the reader to know that in the border-line group there are some pathologists who agree, and some who disagree, with the diagnoses made. The thing to bear in mind with great emphasis is, that no patient has suffered from this disagreement, except now and then from an unnecessary removal of the breast.

What I wish to emphasize also is, that the operation for these border-line tumors in two stages yields just as good results as in one stage, and apparently it has been the results in cases of this kind in the past that have impressed surgeons that it was not dangerous to operate for cancer of the breast in two stages. It is apparently just as dangerous today

to operate for fully developed cancer in two stages, but it is not dangerous to operate for a benign or precancerous lesion in two stages. In fact, it must be remembered that in many of these latter cases the second operation was unnecessary. I am confident, however, that the complete removal of the breast is a definite protective procedure in certain non-encapsulated lesions of the breast which may be included under the terms chronic mastitis and chronic cystic mastitis.

CYSTIC AND SOLID TUMORS OF THE BREAST

The simple cyst (Fig. 311) is characterized by a distinct blue dome, smooth wall and non-hemorrhagic contents; the papillomatous cyst (Fig. 321) by the intracystic papilloma; the galactocele (Fig. 302) by its milky contents and smooth wall. The chronic pyogenic abscess (Fig. 303) contains cloudy material and has a wall which looks like granulation tissue. The tuberculous abscess (Fig. 304) contains the usual pus and pretty characteristic granulation tissue in the wall.

In contrast to these benign cysts, the malignant cyst (Fig. 305), whether cancer or sarcoma, has hemorrhagic contents without papilloma, or a thick grumous material entirely different from the contents of a pyogenic or tuberculous abscess, and some thick area in its wall which an expert surgeon could select for frozen section.

The *solid* tumors of the breast must be divided into those encapsulated, circumscribed, and infiltrating.

In my experience distinct encapsulation is a sign of a benign tumor, usually some form of an adenoma—cystic, fibrous or intracanalicular. In these cases one is helped most by the gross appearance. The histological picture of the intracanalicular myxoma is the least confusing; that of the cystic and fibrous adenoma is frequently interpreted as doubtful or malignant, when the microscopic appearance only has been considered.

Medullary carcinoma, scirrhus, adenocarcinoma and sarcoma may be circumscribed. The gross and frozen-section appearance of all but adenocarcinoma is so distinct that no surgeon should today ever make the mistake of performing an incomplete operation for these forms of cancer of the breast. When, however, certain benign lesions resemble these more malignant forms in the gross appearance or frozen section, the mistake of the complete operation will have to be made.

Certain types of adenocarcinoma are easy to recognize: The colloid

from its intercellular substance, and the duct cancer (comedo adenocarcinoma) from the characteristic worm-like tubules which can be expressed from the cut surface.

The type of adenocarcinoma difficult to recognize is that closely associated with cystic adenoma, a more or less circumscribed tumor, and chronic cystic mastitis, a diffuse lesion.

The diffuse benign lesions of the breast are most difficult of all. We have, first, during lactation the chronic mastitis with no large areas

FIG. 311.—Photograph of simple cyst surrounded by a zone of breast. Note the distinct cyst wall, smooth surface, one dilated duct and many adenomatous areas of surrounding breast.

Path. No. 19040.—White, female, aged 38. Tumor and pain three weeks. Operation, 1910. Excision of cyst and zone of breast. 1916, six years, well. This photograph illustrates how a simple cyst should be excised after it is explored.

of pus formation. Then, in the non-lactating breast different forms of chronic cystic mastitis and chronic mastitis without cyst formation.

I shall attempt to present one or more illustrations of the different groups.

At this time I again wish to make the emphatic statement that in the great majority of cases a decision as to what is best for the patient can be more readily made from the gross appearance. Frozen sections

can be made. We need some differential staining method for more exact diagnosis.

CYSTIC TUMORS

Simple Cysts.—Usually on palpation the tumor is spherical and tense (Fig. 309) and suggests a cyst, but in some cases when it is buried in breast tissue one palpates the mass of breast tissue containing the cyst, and the area feels more like a cancer than a cyst.

When explored carefully, the thin cyst wall appears as a blue dome. One may pass through skin and fat only, before the cyst wall is reached,

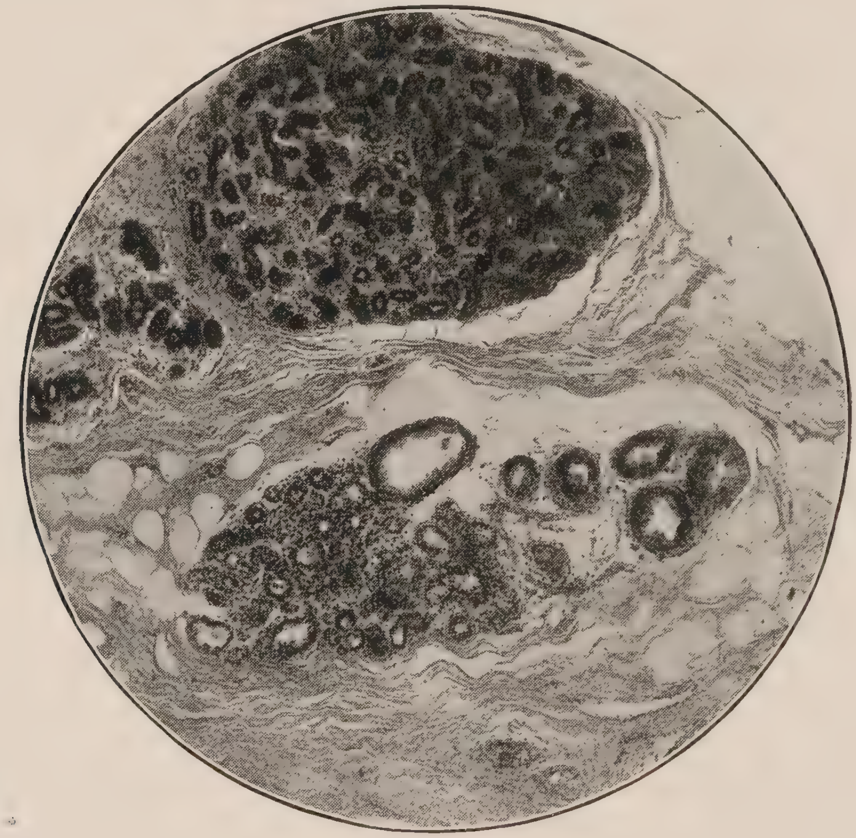

FIG. 312.—Adenomatous areas in zone of breast removed with a simple cyst. Some areas show beginning ectasia.

Path. No. 16133.—White, female, aged 45; tumor and pain 12 days. Excision of cyst and zone of breast. 1916, well two years.

or also through a zone of breast tissue. The moment the thin wall is nicked the color disappears. The lining of the cyst is always smooth; the contents clear or cloudy; never hemorrhagic, nor grumous, thick material.

The cyst wall (Fig. 311) is usually thin; but even when slightly thicker, it is sharply demarkated from the breast tissue. When this cyst is cut out with a zone of breast, one may encounter dilated ducts filled with green, gray or yellow grumous pastille material, other cysts of different sizes, and, scattered in the white opaque breast tissue, one

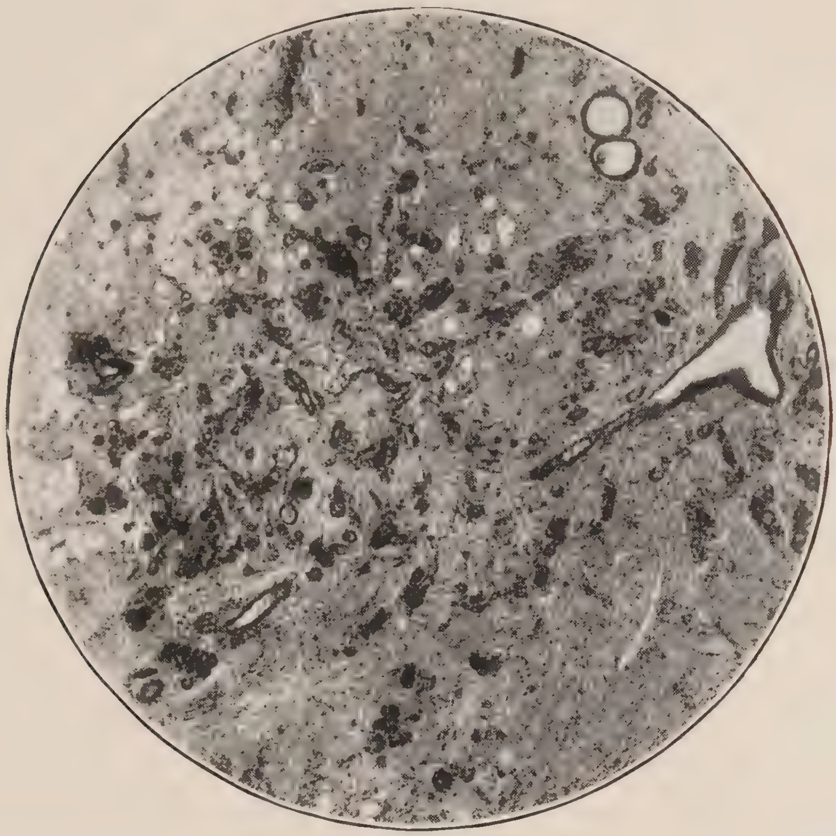

FIG. 313.—Irregular adenomatous areas and dilated duct in breast containing multiple cysts and early chronic cystic mastitis.

Pathol. No. 16786.—White, female, aged 45; pain five days, tumor four days. 1915, excision of zone of breast containing a few small cysts. 1916, one year, well.

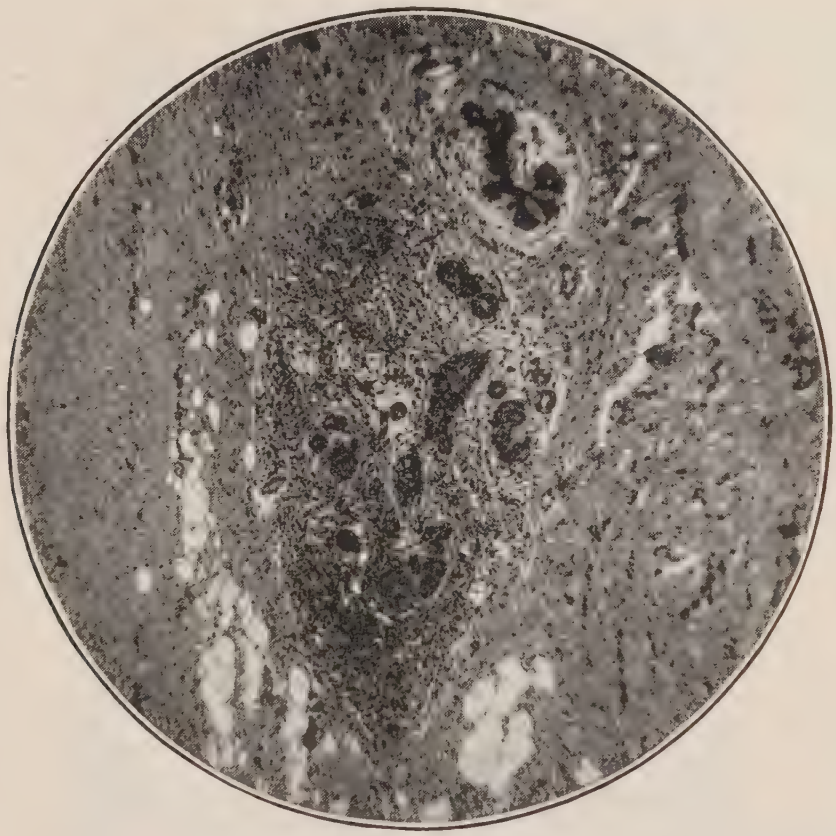

FIG. 314.—Area of chronic mastitis in breast near wall of simple cyst.

Pathol. No. 8717.—White, female, aged 45; tumor five weeks, one week after trauma. 1908, complete excision of breast because of multiple cysts. 1916, eight years, well.

FIG. 315.—Area of ectasia in breast containing multiple cysts and dilated ducts.

Pathol. No. 9394.—White, female, aged 67; tumor and pain six weeks. Nipple retracted; only one tumor palpable. 1908, complete operation for cancer based on retracted nipple. Breast contained three simple cysts. 1916, eight years, well.

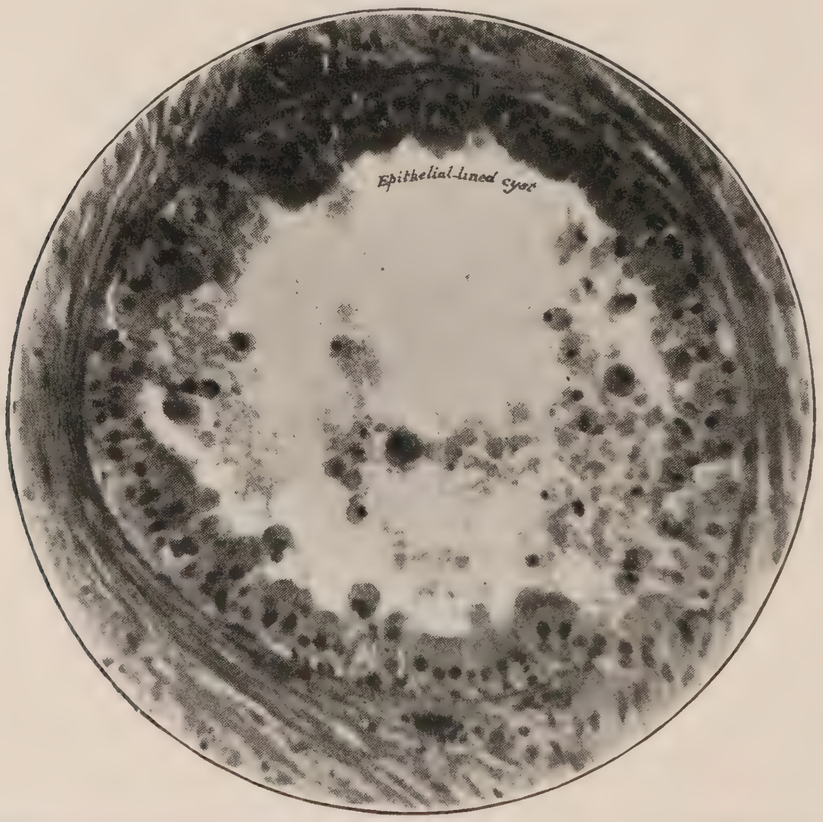

FIG. 316.—Epithelium-lined minute cyst in breast containing multiple cysts and dilated ducts.

Pathol. No. 9394.—For history see Fig. 315.

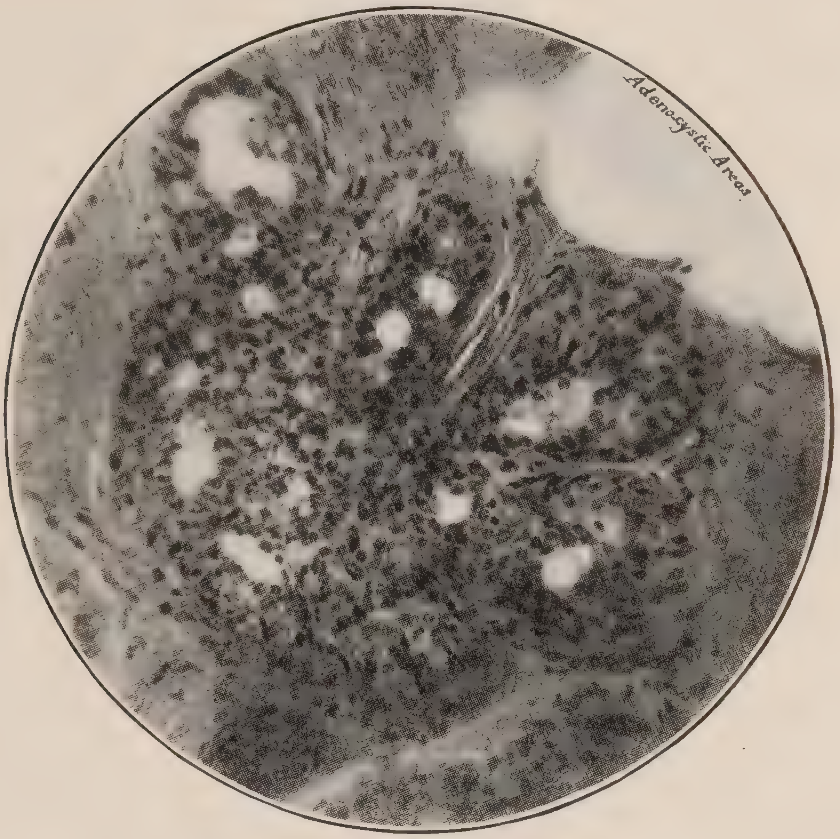

FIG. 317.—Adenocystic areas in breast containing multiple cysts and dilated ducts.
Pathol. No. 9394.—For history see Fig. 315.

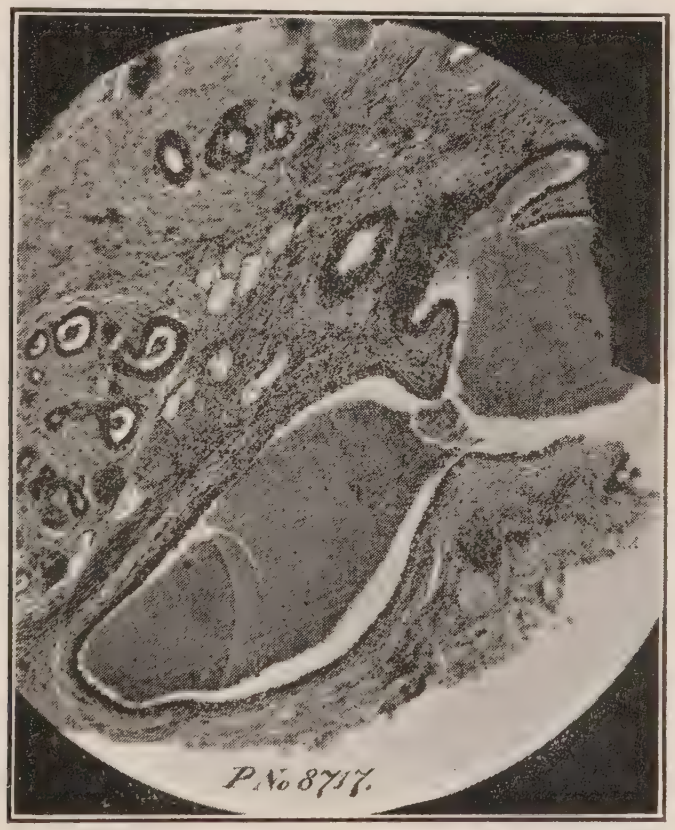

FIG. 318.—Dilated ducts, lined with basal cells, filled with grumous material. Breast the seat of multiple cysts and dilated ducts.
Pathol. No. 8717.—For clinical history see Fig. 314.

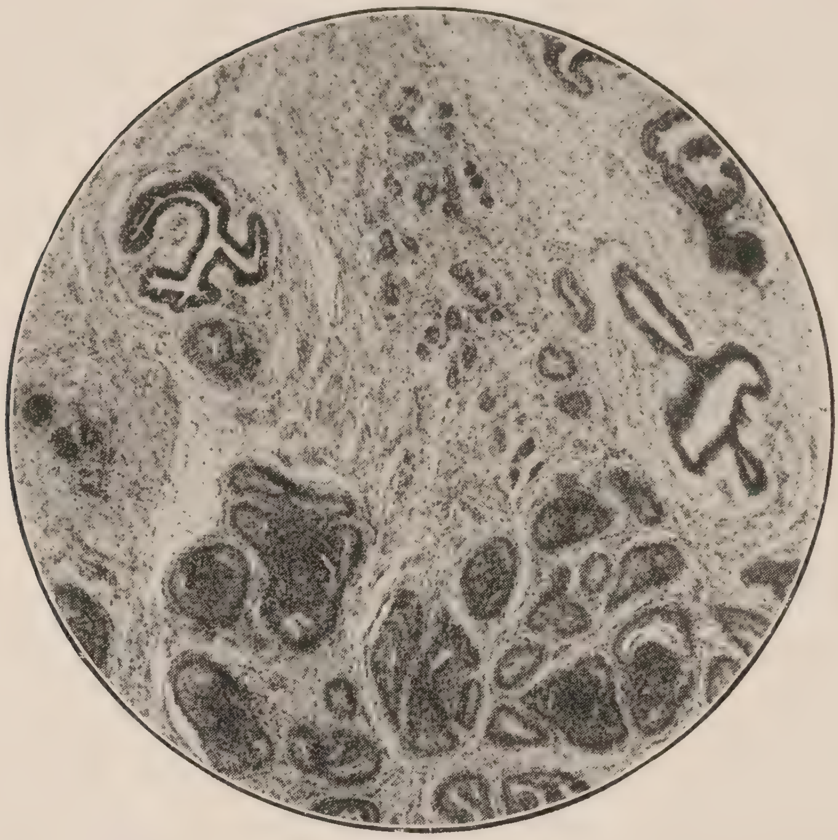

FIG. 319.—Area of duct adenoma in zone of breast about a simple cyst.
Pathol. No. 14095.—White, female, aged 37; pain three months, tumor one month. 1913, excision of cyst and zone of breast. 1916, well.

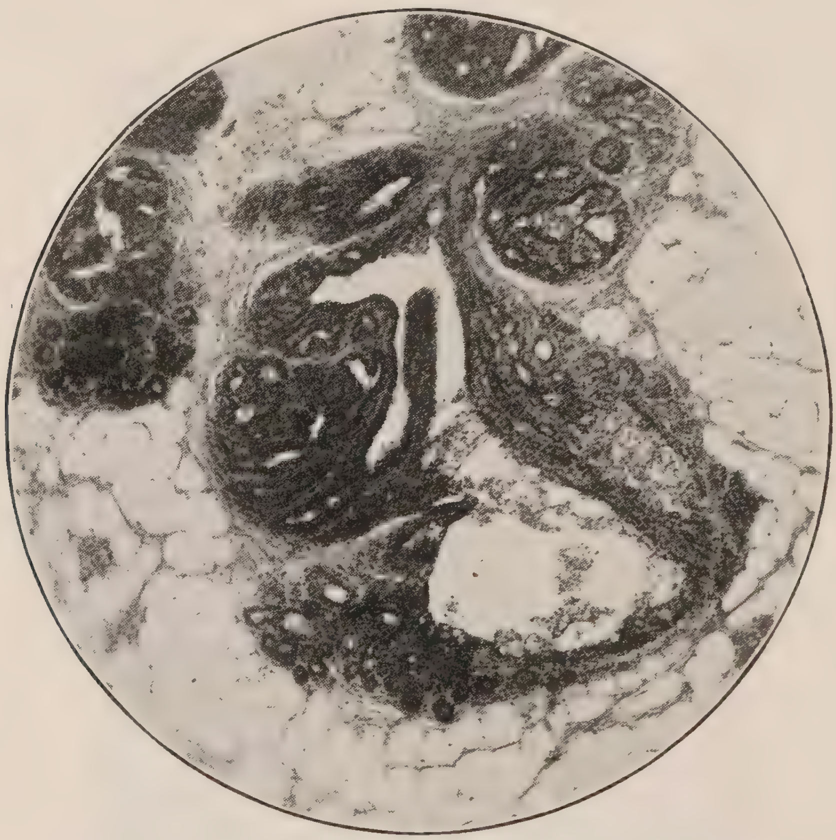

FIG. 320.—Area of duct papilloma in chronic mastitis in breast about a simple cyst.

Pathol. No. 16133.—White, female, aged 45; tumor and pain 12 days. 1914, excision of cyst in zone of breast. 1916, well.

This patient's left breast had been removed seven years before apparently for a simple cyst.

may see the pink elevated dots of the adenomatous hypertrophy which is apparently the first stage of the chronic cystic mastitis. The practical point, however, is that in an experience with 178 cases there is little or no relation between this cyst and cancer, and in the great majority of cases the breast can be saved.

However, when microscopic sections are made of the wall, we may find all stages of chronic cystic mastitis (Figs. 312 to 320) and areas which, if we did not know the gross pathology, might be considered sufficiently suspicious to justify the removal of the breast.

It is frozen sections from the breast about these blue-domed cysts which give cellular pathologists their dilemmas.

Papillomatous Cysts.—The majority of surgeons fear to do a conservative operation for a cyst with a papilloma, especially when it contains blood. However, if these papillomatous cysts are subjected to operation in the early benign stage, there is absolutely no necessity for the removal of the breast. The cyst is not blue-domed as is the simple cyst. When opened it usually contains blood-stained serum. The papillomata may be of various sizes, partially or completely filling the cyst, but the surface is always papillomatous. This is lost in the malignant papilloma. When excising the benign papillomatous cyst, study the breast tissue. If other papillomatous cysts are encountered, or if there are a number of dilated ducts and small cysts, remove the breast, a procedure which is not followed in the benign blue-domed cyst. If the breast tissue is normal, remove the cyst only. Fig. 321 pictures a papillomatous cyst with a zone of breast removed with it. After one has removed the cyst, its wall with the base of the papilloma should be studied. If beneath the papilloma there is no distinct wall, but an invasion of the breast by the papilloma, immediately perform the operation for cancer.

In some cases of papillomatous cysts thus conservatively treated many pathologists have diagnosed the microscopic section cancer. In the case represented in Fig. 322 there has been no recurrence 19 years after the excision of the papillomatous cyst only.

At the present time a large per cent. of papillomatous cysts are treated by the removal of the breast, or the complete operation for cancer. Especially now that women are coming earlier with the lump, this mutilating operation should be performed less, and without any added risk to the patient.

Galactocele, a cystic tumor due to the accumulation of milk in a dilated duct. Clinically I have never been able to make out the bottle-

shaped form mentioned in the literature. To have a true galactocele there must be, or have been, lactation. My observations show that lactation hypertrophy may persist in the breast 14 years after nursing the last child (Fig. 323). Apparently the cause of this is some local

FIG. 321.—Benign papillomatous cyst in a senile and fibrous breast; some dilated ducts and chronic cystic mastitis.

Pathol. No. 17514.—White, female, aged 66; tumor after trauma eight months; no discharge from nipple. On account of the slight infiltration of the skin (probably the result of the trauma) complete operation for cancer (1915). 1916, one year, well.

irritation, such as a galactocele, a benign tumor, or a chronic mastitis. As long as there is lactation hypertrophy in the breast and a plugged duct, galactocele is possible.

In the 20 years previous to 1910 we observed but two galactoceles, since 1910 twelve. In the past, therefore, we have either over-

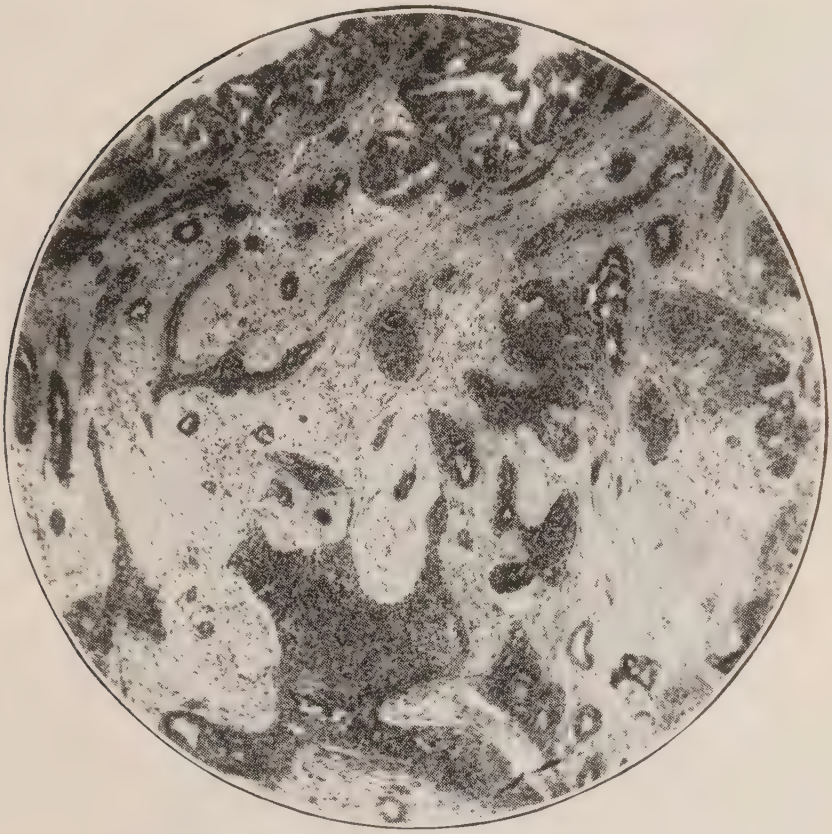

FIG. 322.—Benign papillomatous cyst. Section from papilloma.
Pathol. No. 1596.—Operation in 1896, excision of cyst and zone of breast.
White, female, aged 45; discharge of blood from nipple 15 years; tumor 10 years. 1915, 19 years, well.
This section has been considered by many pathologists as carcinoma.

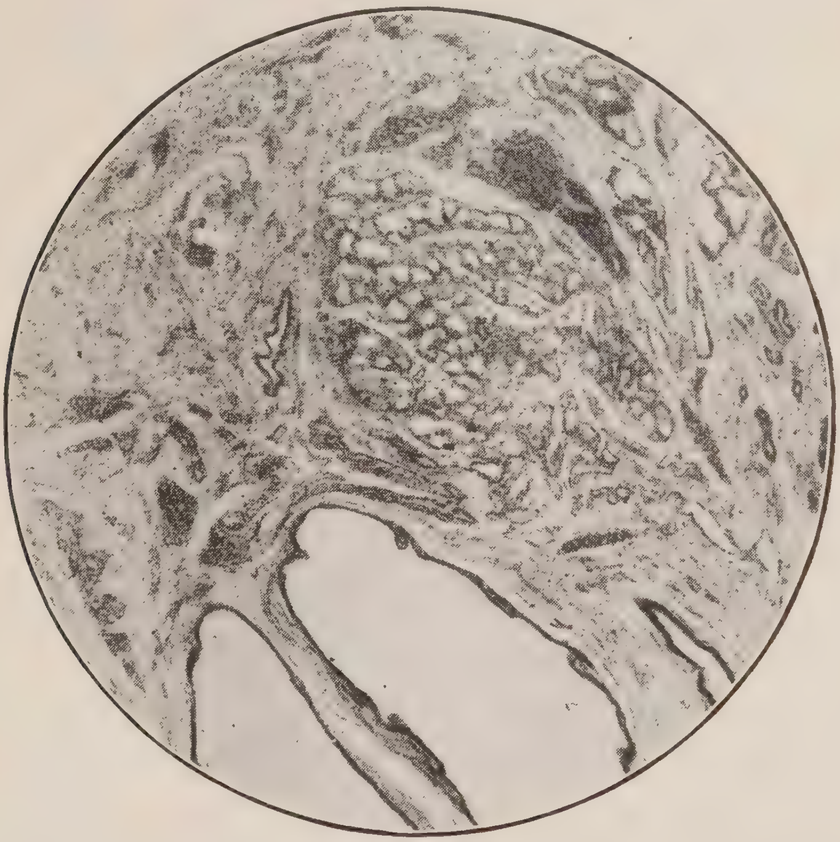

FIG. 323.—Area of residual lactation hypertrophy and dilated ducts.
Pathol. No. 5088.—This breast was also the seat of a medullary carcinoma.

looked galactoceles, or, on account of delay, the patient has come under observation with cancer. As a rule with the galactocele the breast is the seat of mastitis or areas of lactation, or there may be multiple galactoceles (Fig. 324). In the majority of cases the condition is mistaken clinically, at the exploratory incision, or even in the frozen section, and treated as malignant. There is nothing of special difficulty in recognizing the galactocele with its smooth wall and milky contents. But when the breast is the seat of mastitis, areas of lactation hypertrophy, and dilated ducts filled with creamy material, we have a con-

FIG. 324.—Multiple galactoceles and dilated ducts.

Pathol. No. 8166.—1907, excision of breast. White, female, aged 34; history of abscess in this breast some years ago. The patient is nursing her child aged 20 months. Latcation in the affected breast, scanty. Lump observed, six months. In addition to tumor multiple nodules in breast. After operation, cream-like material could be expressed from the dilated ducts.

fusing picture, and the probabilities are that the majority of surgeons will do the complete operation for cancer—the safer procedure. It is quite possible that if we see the galactocele quickly as was my good fortune in the last two cases of two and five weeks' duration, there will be but a single palpable tumor, and the typical cyst will be recognized on exploration. Fig. 302 pictures a galactocele in which the condition was treated on the diagnosis of cancer. Fig. 324 shows the diffuse disease of the breast—dilatation of all the ducts often associated with galactocele.

Chronic Lactation Mastitis Abscess.—This disease may appear as a single tumor, and at exploration as a single cyst (chronic abscess) in

an apparently normal lactating breast. The contents of the chronic mastitis abscess is somewhat purulent, but never hemorrhagic or grumous, as in the cancer cyst. Nevertheless its thick wall may give rise to suspicion of cancer. The frozen section (Fig. 303) is to many pathologists even more confusing. The disease should be distinguished from cancer in the gross. When the breast is the seat of chronic mastitis with remaining areas of lactation hypertrophy, we have a clinical, gross and microscopic picture so difficult to recognize with certainty, that I would advise the complete operation for cancer. There is little

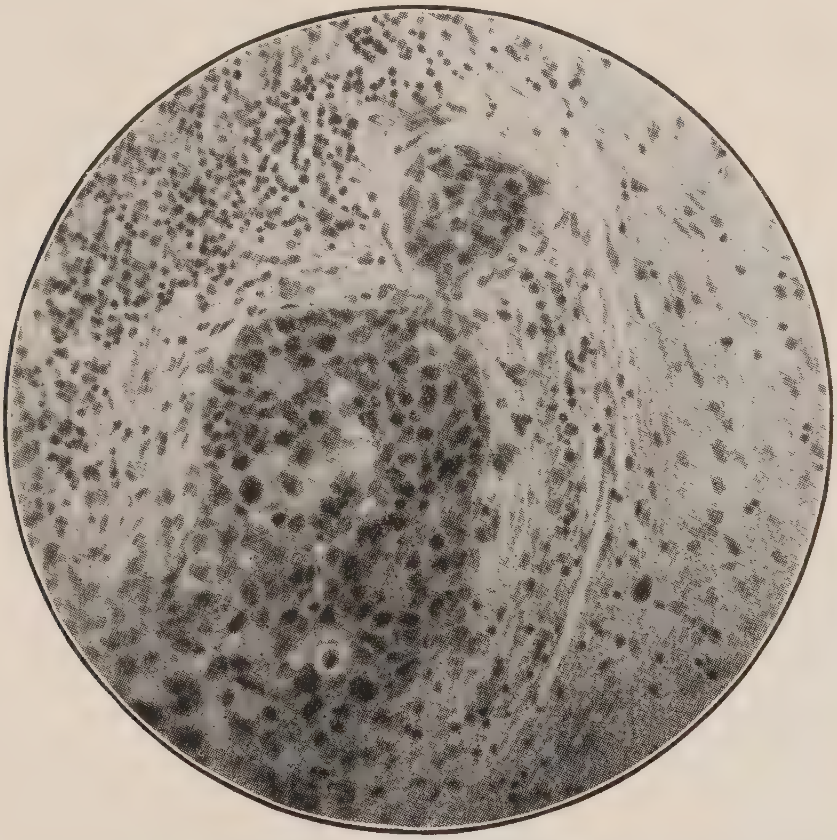

FIG. 325.—Adenocystic changes in tubercular mastitis, suggesting early carcinoma.

Pathol. No. 3170.—Complete operation for cancer in 1900. White, female, aged 35; pain three months; tumor two months; sinus one month.

Ten years later the patient was under observation with tubercular peritonitis. No evidence of cancer.

to lose, as in the majority of these cases the breast must be sacrificed in any event.

Tuberculous Abscess.—We are rarely given the opportunity to see a tuberculous abscess of the breast before it is ruptured. Tuberculosis of the breast is usually a single focus and appears first as an area of induration. Softening with abscess formation takes place, as a rule, before six months and a sinus forms. The tuberculous abscess (Fig. 304) of the breast does not differ in the gross from the same lesion anywhere else. However, microscopically, in the wall of the cavity the

mastitis secondary to the tuberculosis is frequently looked upon as adenocarcinoma (Fig. 325). I have never been able to conclusively prove the presence of cancer in any tuberculous abscess of the breast, although many of these cases had been diagnosed and treated as cancer. In none have the glands shown metastasis, nor have any of the patients died of cancer.

Cancer Cysts.—A smooth-walled cyst with bloody contents and without a papilloma should be treated as cancer. A smooth-walled cyst with thick grumous material is always malignant. In the majority

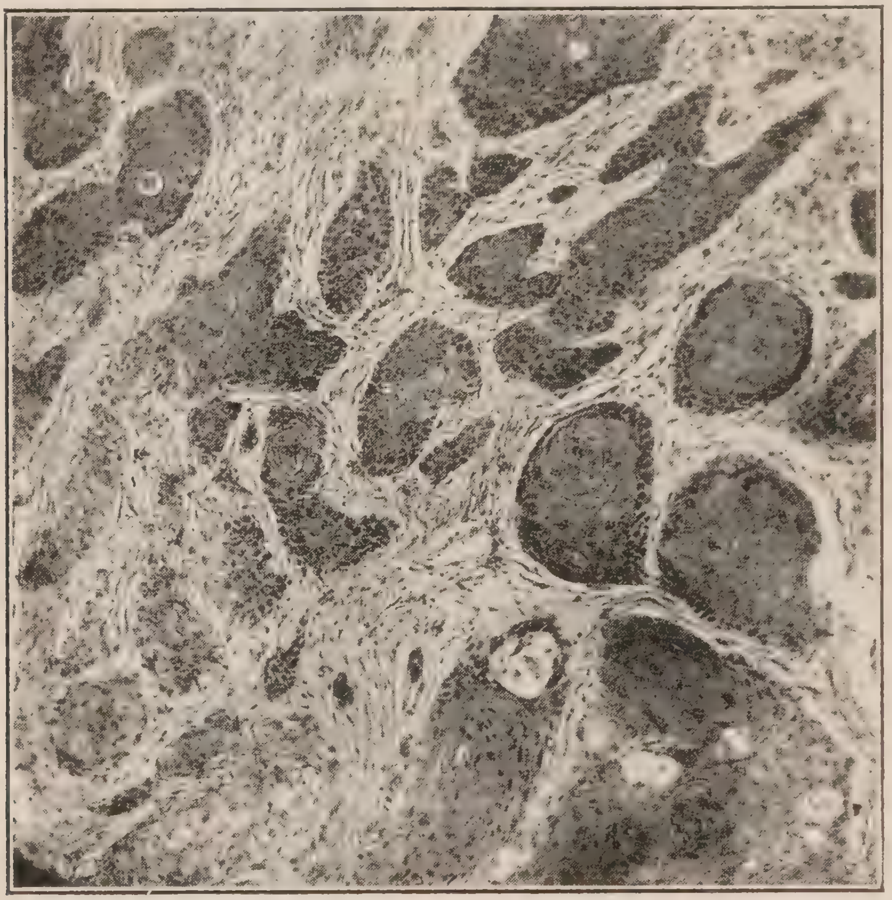

Fig. 326.—Typical fully developed cancer in wall of cancer cyst. Pathol. No. 5252.—Operation in 1904, complete for cancer. White, female, aged 64; pain three months; tumor two months.

of cases cancer can be recognized in the wall of these cysts at the exploratory incision.

In the past smooth-walled cysts containing blood were the cancer cysts not recognized by the surgeons, and treated as benign.

Figure 305 shows a somewhat smooth-walled cancer cyst which contained blood.

In the 20 cases of cancer cysts observed by me, fully developed carcinoma or sarcoma was readily recognized in the microscopic section (Fig. 326).

In the differential diagnosis of the different types of cysts one is helped most by the contents of the cyst, by the character of the wall, by the appearance of the papilloma, if present, and by the careful study of the base of the papilloma. There should really be little difficulty in recognizing the cancer cyst, but when the benign cyst is associated with some diffuse disease of the breast, such as lactation mastitis, chronic cystic mastitis, multiple galactoceles, the surgeon is usually confused and the complete operation for cancer performed.

SOLID ENCAPSULATED TUMORS

The benign solid encapsulated tumors are cystic adenoma, intracanalicular myxoma and fibroadenoma. The common characteristic

FIG. 327.—Encapsulated cystic adenoma removed with a zone of breast. Pathol. No. 2568.—Operation in 1899. White, female, aged 30; tumor 10 years.

which differentiates them from the malignant tumors is the presence of a distinct capsule. One could enucleate them from the surrounding breast. Often, however, at one point the capsule is less distinct and there is the appearance of an isthmus-like connection between the tumor and the breast. I have never observed a malignant tumor with such a capsule.

In the *cystic adenoma* (Figs. 327 and 328) one sees minute cysts throughout the tumor. Some are filled with clear or cloudy fluid, others seem to contain a granular material which, as a rule, does not express on pressure. Microscopically, on account of the large number of pictures met with, these tumors are often diagnosed early carcinoma, and breasts are unnecessarily sacrificed. About 30 per cent. of pathologists diagnosed the section (shown in Fig. 329) cancer. In this case for-

tunately only the tumor had been removed. There has been no local recurrence now four years since operation.

The *fibroadenoma* shows no minute cysts. It may be marked by little crevices or show minute dots, and in addition there are white and gray areas (Fig. 306). In some fibroadenomas there is so little stroma (Fig. 330) that they almost resemble a miniature pancreas. But here again pathologists have been found to disagree in the microscopic study (Fig. 331). Here the diagnosis of malignancy is as five to two benign.

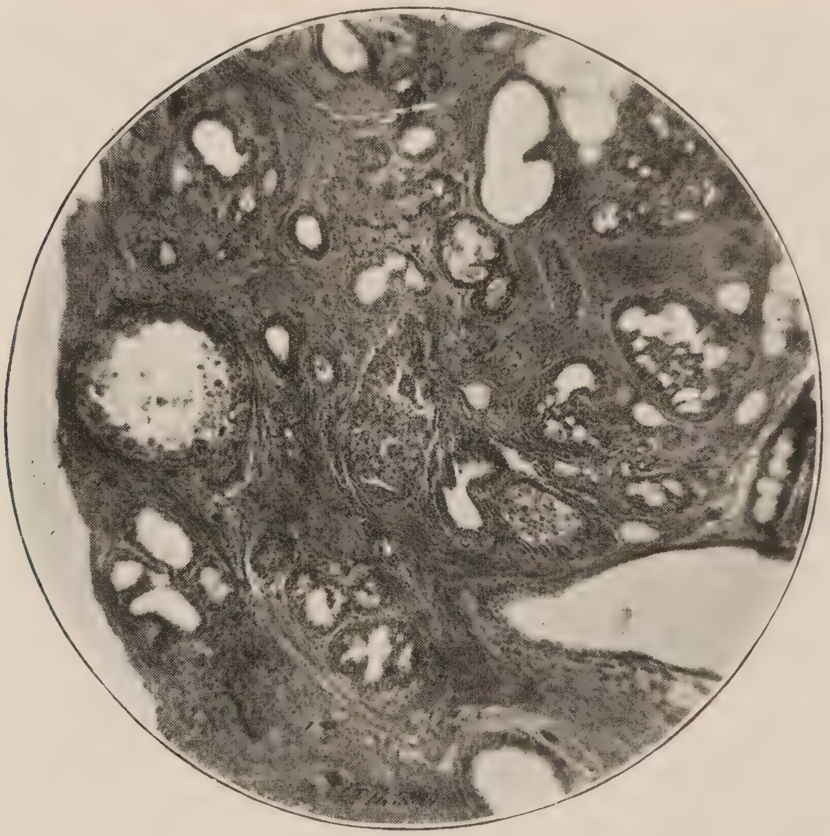

FIG. 328.—The microscopic picture of cystic adenoma and chronic cystic mastitis. Pathol. No. 9394.—For clinical history see legend of Fig. 315. The different types of areas in this zone of breast are designated in Figs. 315, 316 and 317.

When these fibroadenomas are present in the lactating breast, they undergo lactation hypertrophy (Fig. 307), and here the frozen-section diagnosis, when one is not familiar with lactation, is very confusing.

The fibroadenoma situated within the breast rarely reaches great size (a characteristic of the intracanalicular myxoma). When present for a number of years the fibroadenoma may become calcified.

Aberrant Fibroadenomas.—The most frequent tumor observed outside of the breast resembles the fibroadenoma. It may often attain a size larger than that of the breast (Fig. 301) and many of these cases are treated on the diagnosis of sarcoma. The tumor, however, is

always encapsulated. Its gross appearance is typically glandular (Fig. 332), and microscopically it differs from breast tissue at puberty only in the irregularity of the arrangement of parenchyma and stroma (Fig. 333).

FIG. 329.—Cystic adenoma.

Pathol. No. 13599.—Operation in 1912, excision of tumor and zone of breast. 1916, four years, well.

White, female, aged 22; tumor three months. Consulting pathologists differ as to diagnosis.

Intracanalicular Myxoma.—The small intracanalicular myxoma does not differ much, in the gross, from the adenofibroma (Fig. 334). In a few instances the tumor looks so succulent that it gives one the impression of a medullary carcinoma. Here a frozen section will be most helpful, because there is nothing more characteristic than its histology (Fig. 335).

I have been told about, but have never seen, a perfectly encapsulated medullary carcinoma. If there be such a thing, the frozen section will immediately differentiate it. As the intracanalicular myxoma

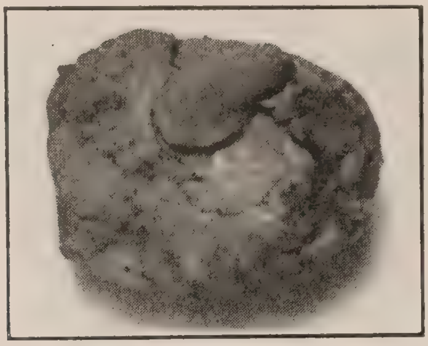

FIG. 330.—Small encapsulated fibroadenoma, excised with a zone of breast; stróma, scanty.

Pathol. No. 19063.—White, female, aged 40; tumor a few months. Operation in 1916 excision of tumor with zone of breast.

For microscopic appearance see Fig. 333.

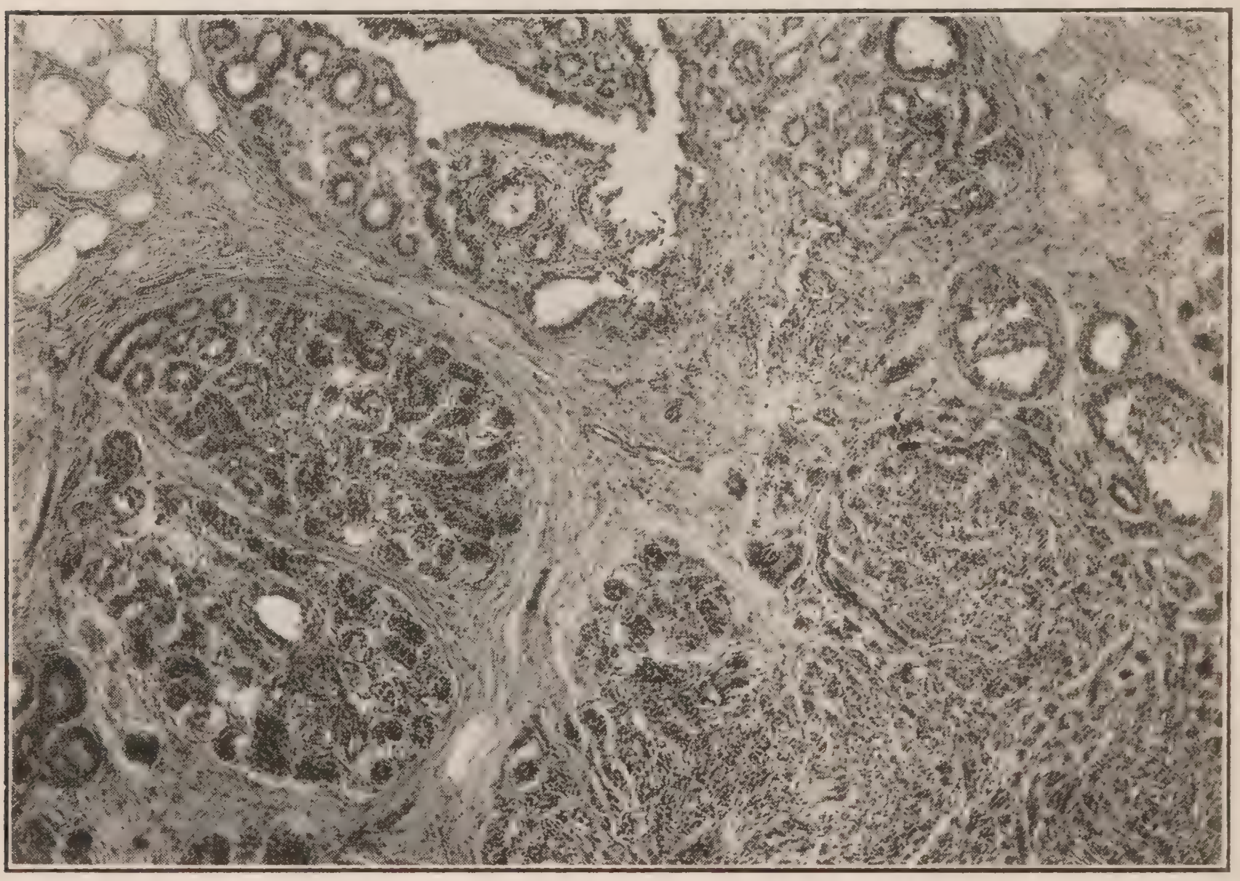

FIG. 331.—Fibroadenoma. Consulting pathologists differ as to diagnosis. The tumor was a small, distinctly encapsulated area in the breast of a young girl under twenty-five. Pathol. No. 19060.—Excision of tumor only.

grows larger, its peculiar gross appearance becomes more characteristic. In this middle stage it has neither the cysts of the cystic adenoma, nor the splits of the adenofibroma, but rather the appearance of the hypertrophied prostate.

The gross appearance of the large intracanalicular myxoma may be variegated (Fig. 336), but there is no necessity for any attempt at diagnosis before operation: These large, apparently encapsulated tumors occupying more than one-fourth of the breast should be treated as sarcoma—the tumor, breast, an area of skin and the greater pectoral muscle should be removed.

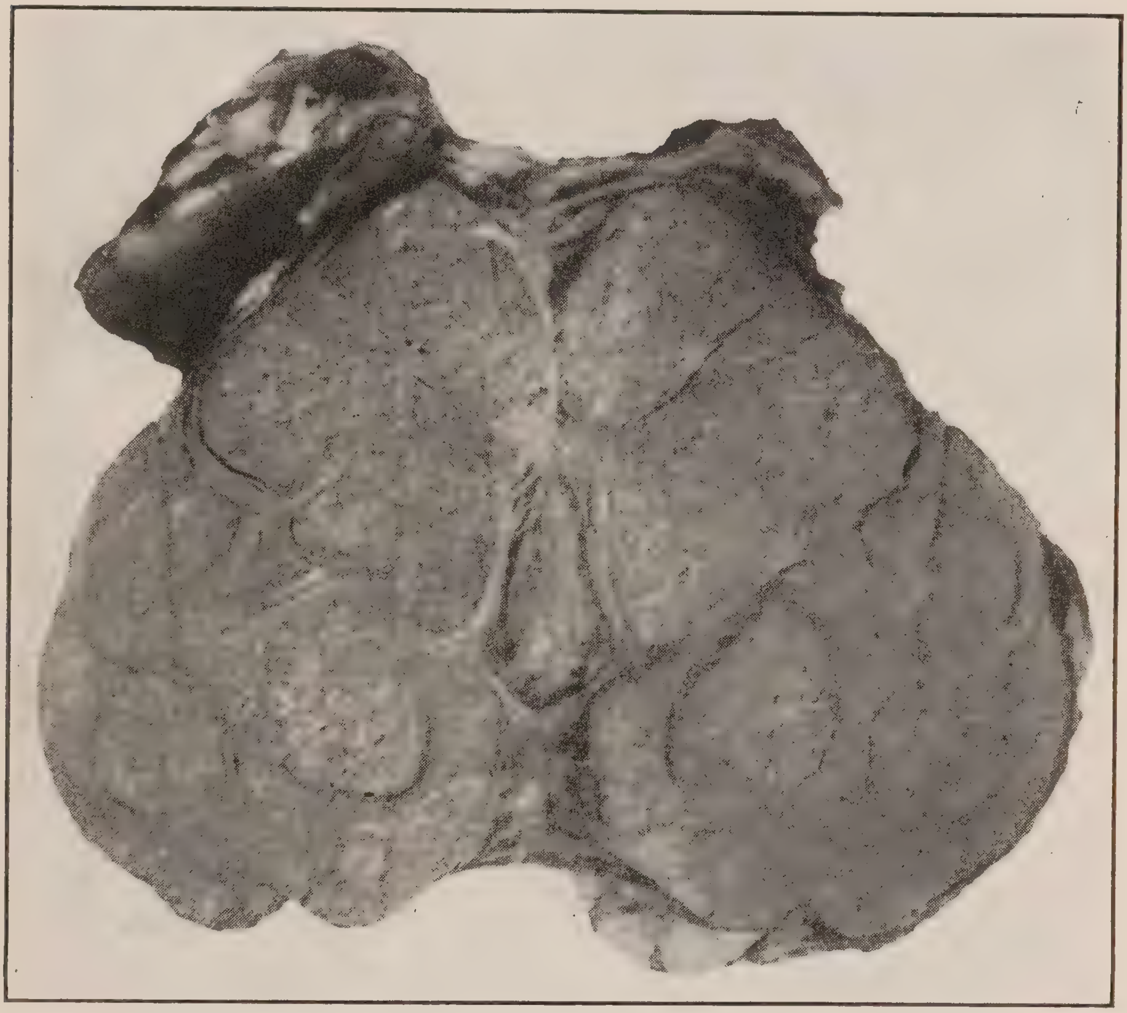

FIG. 332.—Encapsulated, large, aberrant fibroadenoma, incorrectly diagnosed sarcoma. Pathol. No. 6060.—Operation in 1904, complete for sarcoma. Colored, girl, aged 17; small tumor observed shortly after birth; rapid growth since puberty for three years. 1916, twelve years, well.

These three adenomas of the breast should offer but little diagnostic difficulty at the exploratory incision. The chief characteristic is encapsulation.

Malignant tumors may be circumscribed, but they can never be enucleated from the surrounding breast tissue, and when one explores a solid tumor which is not encapsulated, one should treat such a tumor as malignant.

Until recently all the distinct solid tumors which were not en-

capsulated and which were explored by me were malignant. Now that I am seeing cases earlier I have met with a number that are benign.

Circumscribed, but not Encapsulated Benign Tumors.—Figure 337 represents such a tumor which I explored in 1915. There was no capsule, it felt to the finger like cancer, and gave the gritty sensation

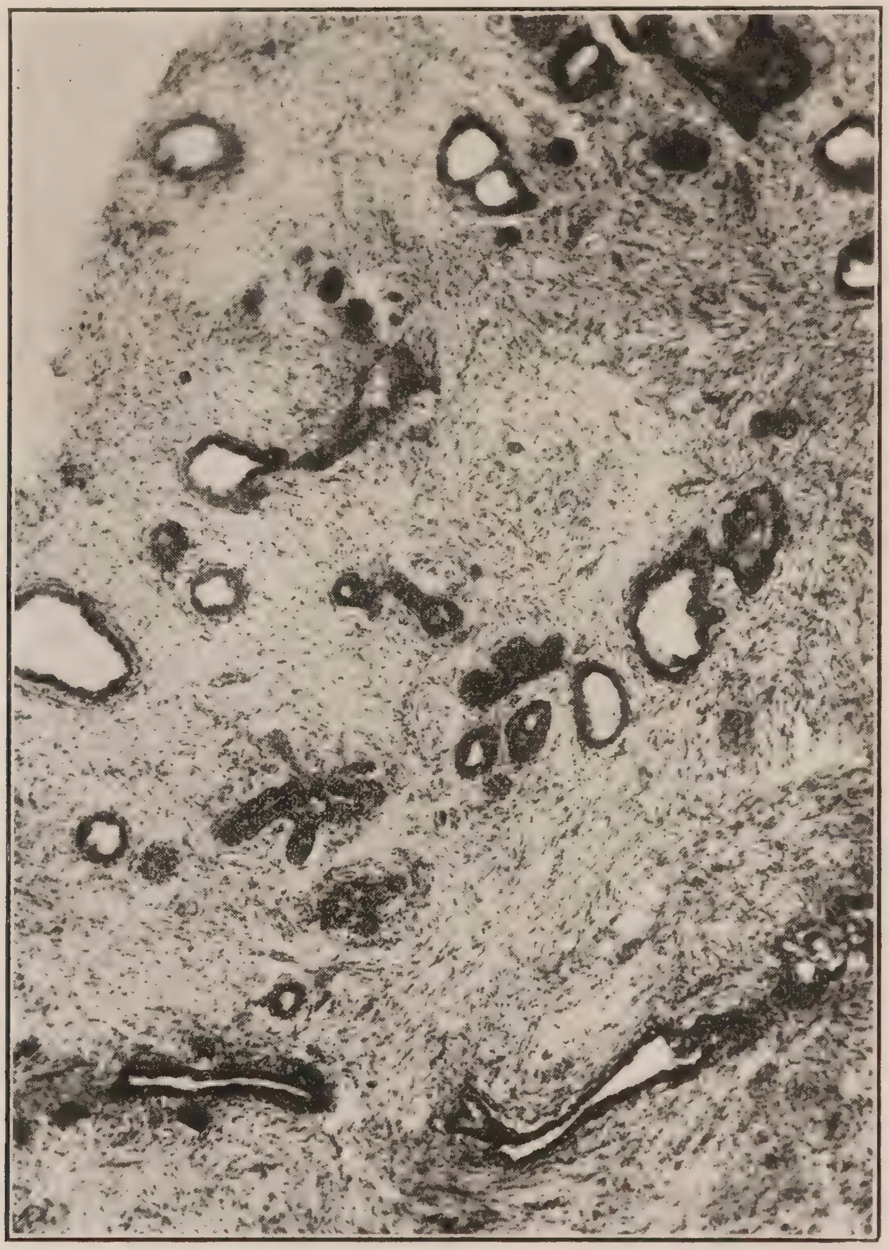

FIG. 333.—Microscopic picture of the usual aberrant fibroadenoma. For gross appearance and history see Fig. 330.

of a scirrhus under the knife. This lump had been in the breast perhaps 20 years, but in the last few weeks had seemed to grow and had become painful. The microscopic appearance is shown in Fig. 338.

We may also observe circumscribed areas of chronic mastitis, chronic cystic mastitis, cystic adenoma and fibroadenomas which

have lost their capsule. Now that women as seeking advice earlier after the first appearance of the tumor, or more quickly after the first change in an old tumor, this new group, most difficult to diagnose,

FIG. 334.—Encapsulated intracanalicular myxoma.
Pathol. No. 18374.—Operation in 1915, excision of tumor and zone of breast.

will increase. So far all the cases recorded by me have been treated on the diagnosis of early cancer.

Chronic Cystic Mastitis.—This disease may appear as a blue-domed simple cyst (Fig. 311) such as I have described. Apparently

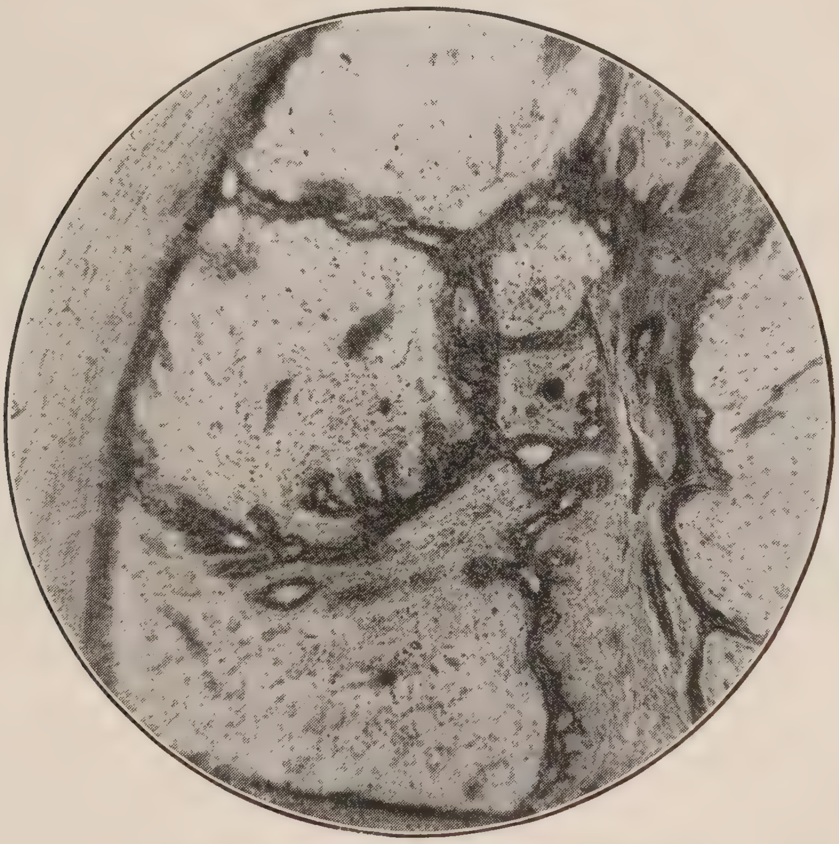

FIG. 335.—Microscopic appearance of intracanalicular myxoma.
Pathol. No. 2761.

this is by far the most common condition. Chronic cystic mastitis is probably present in many breasts, but not until a cyst forms is the patient aware of it. Previous to the formation of the cyst these

patients may experience pain. At the present time we are seeing many women with painful breasts, more than ever before. Again, we are seeing a number of cases of painful breasts in which on examination we find one or more nodules in one or both breasts. True,

FIG. 336.—Large encapsulated intracanalicular myxoma, which usually shows sarcomatous changes and should be treated as sarcoma.

Pathol. No. 17979.—Operation in 1915, excision of tumor only, later on advice from Pathological Laboratory, complete excision of scar and pectoralis major muscle.

White, female, aged 39, tumor, two years. 1916, one year, well.

the nodules are rather indefinite to the experienced, but are often considered tumors by the patient and inexperienced physician or surgeon. When we feel a definite tumor, explore it, and find the blue-domed, smooth-walled cyst (Fig. 311) we have, as I have stated before and wish to repeat here again, clinical and gross evidence of a benign

lesion. As we cut out these simple cysts or when we examine the removed breast, we always find evidence of a diffuse disease of the breast: There are minute cysts of various sizes, dilated ducts filled

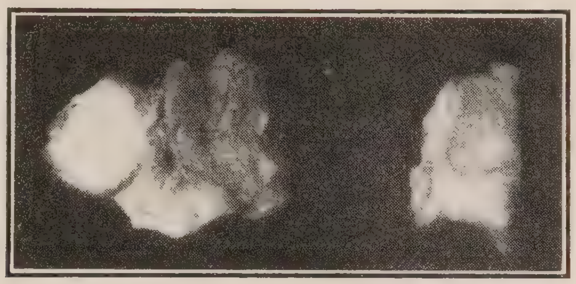

FIG. 337.—Circumscribed, but not encapsulated cystic adenoma. Gross appearance at exploratory incision suggested cancer.

Pathol. No. 17012.—Operation in 1915, exploration followed by complete operation for cancer. White, female, aged 30; little tumor 20 years; recent growth and pain two weeks. For microscopic appearance see Fig. 338.

with grumous material; pink, elevated dots. These may be scattered in the breast tissue, rather diffusely mixed with the fibrous stroma. In cases of this kind they make little impression upon the ordinary

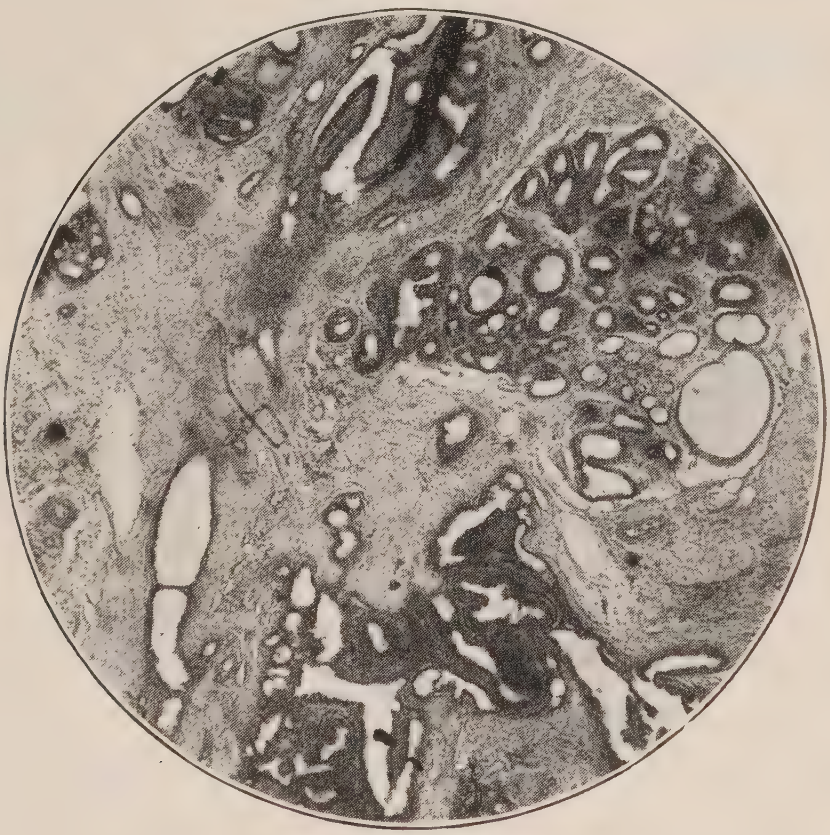

FIG. 338.—Cystic adenoma. For gross and clinical note see Fig. 317. Compare this section with Figs. 328, 329, and 319.

observer. However, we may meet the disease as a circumscribed area when it has the exact appearance of a cystic adenoma, except that it is not encapsulated. A quadrant or a hemisphere, or the entire breast

may be involved in this parenchymatous change (Fig. 339). It has received many names—*Schimmelbusch's* or *Réclus' disease, abnormal involution, senile parenchymatous hypertrophy.* I prefer to return to the old terminology of Billroth—*chronic cystic mastitis.* This pathological process impresses me as a reaction to some irritant. Microscopically and in addition to the parenchymatous changes, there is evidence of reaction in the stroma of the breast. No relation between this disease and any microörganism has yet been established.

In a smaller group of cases there are no large simple cysts (Fig. 339). In this group before operation we may palpate an indistinct tumor, a distinct circumscribed area, or a diffuse shot-like mass involving a quadrant, a hemisphere or the entire breast.

FIG. 339.—Chronic cystic mastitis; no large cysts. N = normal breast; C = minute cysts; X = areas suspicious of adenocarcinoma; Ad = adenocystic areas.

Pathol. No. 3965.—Operation in 1901, complete excision of breast. 1916, 15 years, well. White, female, aged 40; pain six months, nodular enlargement of one quadrant four months. Slight discharge from nipple. After microscopic study of this breast the complete operation was advised, but refused by patient. For microscopic appearance see Figs. 312 to 320 and Figs. 328, 329 and 331.

When we study these areas microscopically we find a great variety of histological pictures, difficult to interpret.

Until three years ago about 50 per cent. of the cases of chronic cystic mastitis without large cysts were looked upon as malignant, in the past three years only 30 per cent.

As we have no exact method of differentiating the benign from the malignant, I am convinced that it is safer in these cases to radically remove the entire breast with the pectoral fascia. If there is any evidence of cancer, operate as you would for cancer.

The time may come when we will be able to differentiate, but at the present time I am convinced that this is the safest procedure.

It seems strange that in the larger group, when we find a definite

smooth-walled cyst, experience shows that it is justifiable to perform the conservative operation of excision of the cyst with a zone of breast tissue. However, in the smaller group when we find no such cysts, but a circumscribed or diffuse area of the cystic mastitis, experience teaches us that it is safer to remove the breast.

A most thorough gross and microscopic study of almost 300 such cases shows not much difference in the breast about the simple cyst, in the chronic cystic mastitis without large cysts, and in the chronic cystic mastitis associated with definite carcinoma.

I have submitted a large number of these cases to a group of experienced pathologists and found a great divergence of opinion. It would, therefore, be a mistake to present this disease as a well-established entity in which exact diagnosis is possible.

Cancer in Chronic Cystic Mastitis.—In 18 cases of cancer cysts the presence of chronic cystic mastitis in the surrounding breast has been conspicuous by its absence. So we have no evidence that the cancer cyst begins in this disease.

When scirrhus and medullary carcinoma predominate in the picture of the tumor, one pays little attention to the surrounding breast, as an indication for operation.

In those cases in which at the exploration we do not find a zone of scirrhous or medullary carcinoma, but an area of chronic cystic mastitis as pictured in Fig. 339, the difficulties of differential diagnosis in the majority of cases are sufficient to justify the complete excision of the breast, and in some cases the complete operation for cancer.

In 50 cases we have made the diagnosis of benign, chronic cystic mastitis. As far as I know, not a single one of these patients has subsequently died of cancer. In 13 of these cases the small zone which was palpated before operation did not show the fully developed chronic cystic mastitis as illustrated in Fig. 339, but rather the character of the breast tissue pictured in Fig. 321. Microscopically, the tissue excised showed evidence of the adenomatous stage only (see Fig. 312). I am inclined to think that careful scrutiny at the exploratory incision with the aid of a frozen section will distinguish these cases and allow a conservative operation.

In 18 cases the breast was completely removed, in 6 both breasts, and in 13 the complete operation for cancer was done.

It is true that in some of these cases there was no indication for either the removal of the breast or the complete operation for cancer, because gross and microscopically the tissue removed resembled that in

the first group. But in the majority of cases the gross appearance of the palpable and explored area corresponded pretty closely to that shown in Fig. 339, and the microscopic to that in Figs. 312 to 320.

It is interesting to note, however, that the breast in these 50 cases diagnosed benign chronic cystic mastitis differed very little, except in degree, from 170 cases diagnosed simple cyst in chronic cystic mastitis. It is very difficult to explain the development of the large cyst in the larger group.

In 128 cases single simple cysts similar to that illustrated in Fig. 311 were present. In 54 of these cases only the cyst and a zone of the breast was excised. In one of these cases three years later a cancer formed in another zone of the breast. The patient presented herself

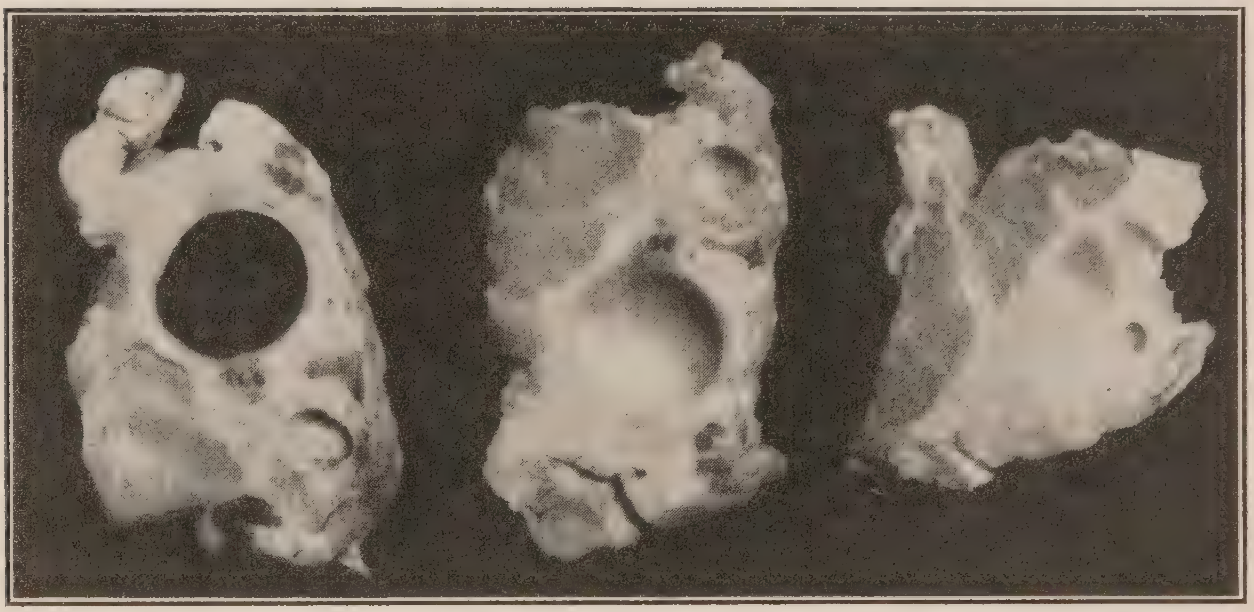

FIG. 340.—Chronic cystic mastitis with multiple cysts.
Pathol. No. 15359.—Complete operation for cancer in 1913. White, female, aged 45; pain 15 months; tumor one year (disappeared once). 1916, three years, well.

immediately, it was recognized at the exploratory incision, and the patient is well five years since the complete operation for cancer. The microscopic appearances of the breast about these cysts is shown in Figs. 312 to 320.

In forty-eight cases for various reasons the breast was excised. In twenty-six cases the operator suspicious of malignancy performed the complete operation for cancer. In a few cases because of a retracted nipple and dimpled skin. In a few others on account of the complicated gross pathology (Fig. 340) multiple minute cysts and dilated ducts. In a few cases after microscopic study.

In 42 cases, clinically, there were multiple tumors, and at operation multiple cysts were found (Fig. 340). In 10 of these cases the breast

was preserved, in 19 cases one, and in 13 both breasts were removed. The microscopic study of these breasts with multiple cysts differs from the breast containing a single cyst only in the number of simple cysts, and as a rule the chronic cystic mastitis is present to a larger extent.

During the same period of 25 years we have recorded 25 cases of cancer in chronic cystic mastitis or senile parenchymatous hypertrophy. In none of these cases was there found a fully developed area

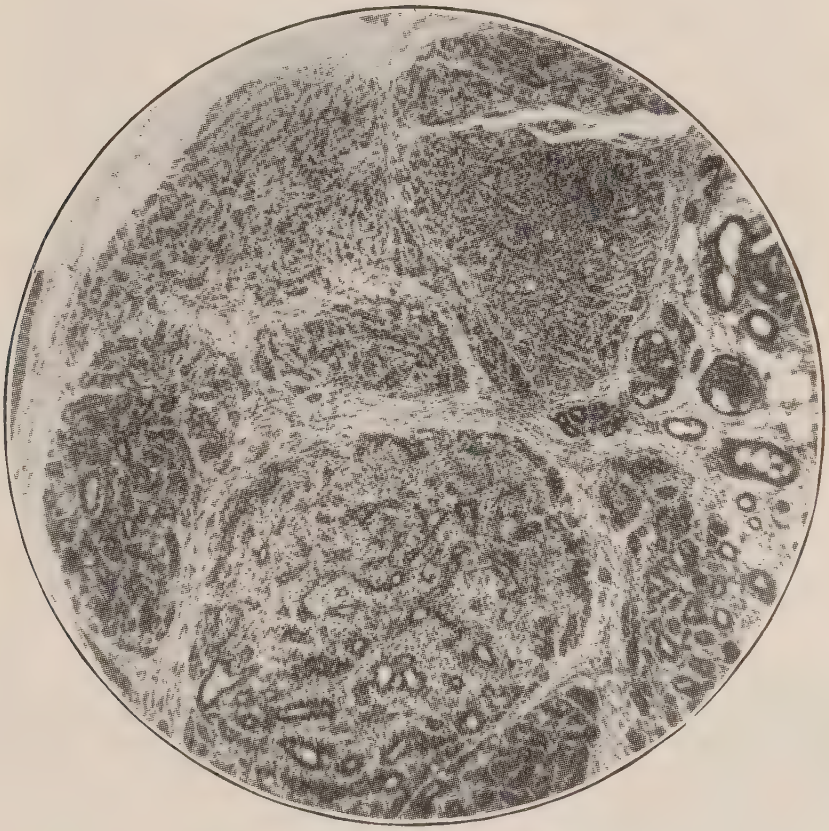

FIG. 341.—Early adenocarcinoma in adenomatous areas.

Pathol. No. 13204.—Operation in 1912, exploration followed by the complete operation for cancer. White, female, aged 49; intermittent retraction of the nipple 18 months; pain and tumor four months. Two years later excision of other breast for similar condition. 1916, four years, well.

of scirrhous or medullary carcinoma. In this group there is only one patient dead of cancer, and in this case we find after serial sections an area of fully developed cancer about which no pathologists would disagree. The other cases have all been submitted to a number of consulting pathologists, and not in a single case is there uniform agreement.

It is important to note, however, that in every one of these cases the breast was completely removed as shown in Fig. 339. In four cases the excision of the breast was the extent of the operation, in five cases the

operation consisted first of the removal of the tumor followed after an interval by the complete operation for cancer.

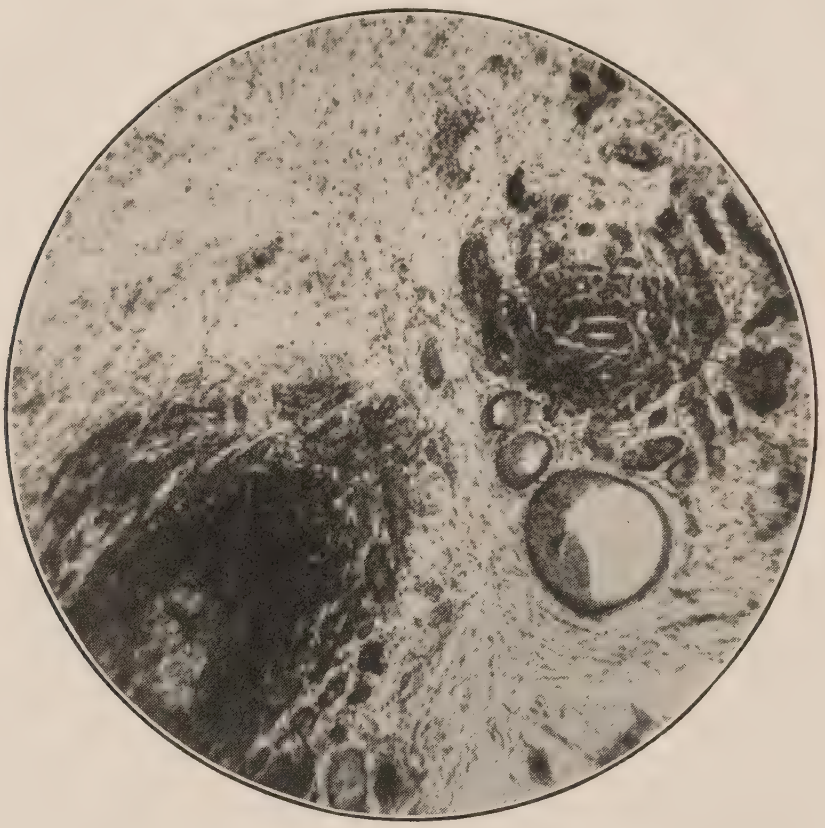

FIG. 342.—Adenocarcinoma in adenomatous areas.

Pathol. No. 11799.—Operation in 1911, excision of tumor; a few weeks later complete operation for cancer. 1916, five years, well.

White, female, aged 26, tumor two months. The tumor in the gross resembled Fig. 337.

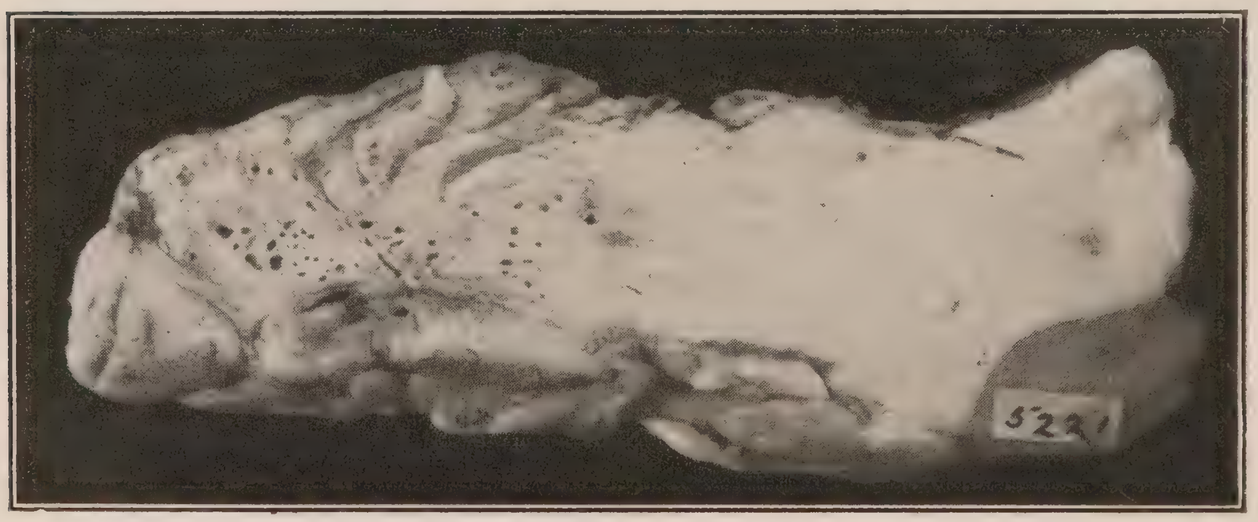

FIG. 343.—Cancer (?) in chronic cystic mastitis. Photograph of the section of breast removed.

Pathol. No. 5221.—Operation in 1904, excision of breast only. 1916, 12 years well.

White, female, aged 46; enlargement of one quadrant of the breast four months. For microscopic appearance see Fig. 344.

It seems to me that the key to the situation is the one case in which there was a death from cancer in spite of the complete operation. In

all breasts which show the type of chronic cystic mastitis as illustrated in Fig. 339 the complete operation for cancer is the safer procedure.

Microscopic Study.—When these cases were studied under the microscope histological pictures were found never observed in the 170 cases of chronic cystic mastitis with large cysts, and 50 cases of chronic cystic mastitis without large cysts. Figs. 341 and 342 have been considered adenocarcinoma beginning in adenomatous areas and should be compared with Figs. 312, 313, 314, 331 and 333. Figs. 343 and 344 have been looked upon as adenocarcinoma in adenocystic areas and should be compared with Figs. 317, 328 and 329.

Fig. 344.—Adenocarcinoma on adenocystic area. Compare with Figs. 317, 328 and 329. For gross appearance and history see Fig. 343.

Duct Carcinoma (*Comedo Adenocarcinoma*).—At the exploratory incision this has such a distinct gross appearance that one should never fail to recognize it. It may appear as a circumscribed, but not encapsulated tumor similar to Fig. 337, or as a diffuse area involving a quadrant, hemisphere or the entire breast, as in Fig. 345. From the cut surface of the tumor, no matter what its size, one can express worm-like necrotic tissue after which there is left a little space, as shown in Fig. 345. Microscopically (Fig. 346), it is as characteristic as in the gross, and easily distinguished from the benign duct adenoma (Fig. 319). I saw

and described this tumor first in 1893, and up to the present time I have records of 23 cases, in which the tumor, in the gross and microscopic appearance resembled Figs. 345 and 346. In not one of these cases has there been metastasis to the glands in the axilla, nor have any of the patients died of cancer. The tumor is often associated with retraction of the nipple, ulceration, and even the development of a fungus.

Duct cancer resembles chronic cystic mastitis in that there may be a circumscribed area, or a diffuse change in part of, or in the entire breast. Comedones and duct adenomas are not infrequently observed in small areas in chronic cystic mastitis.

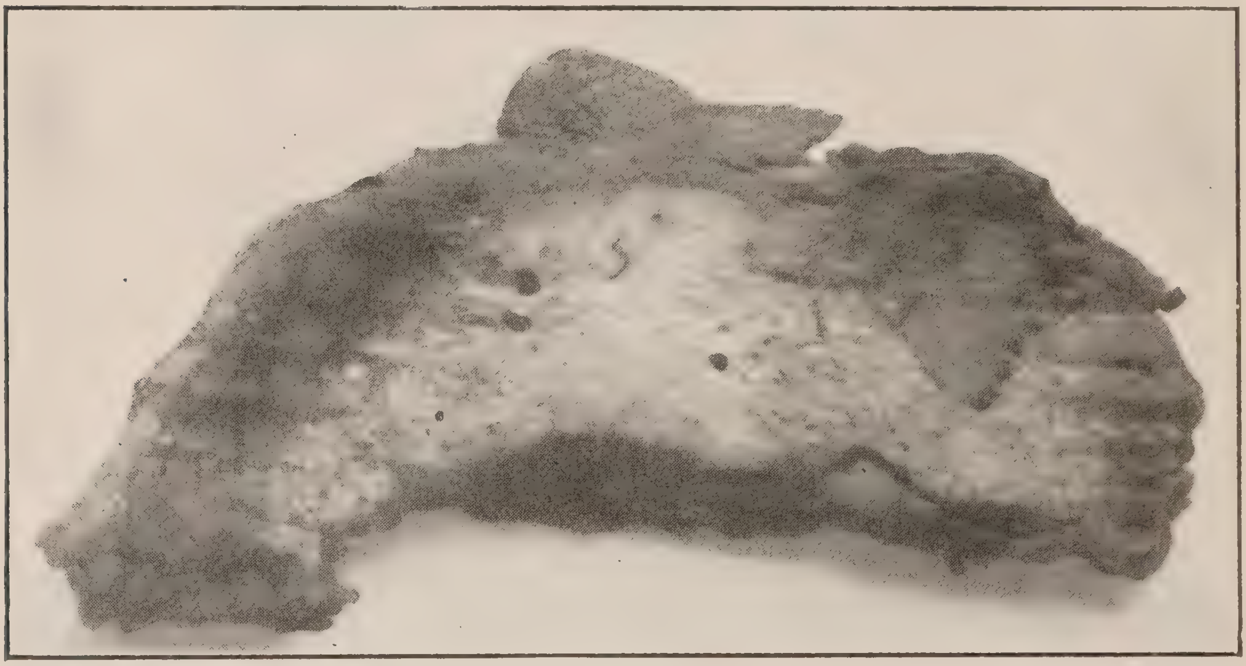

FIG. 345.—Duct cancer, involving the entire breast (comedo adenocarcinoma). Section of breast through nipple.

Pathol. No. 15427.—Operation in 1914, exploratory followed by complete for cancer. White, female, aged 38; tumor 2 years, associated with slight discharge of grumous material from nipple and pain. 1916, well.

In a larger number of cases this duct carcinoma has been present in small or large areas of a fully developed scirrhous or medullary carcinoma. In the latter group the glands often show metastasis, and the probability of a cure is identical with that in the fully developed scirrhous or medullary carcinoma.

Adenocarcinoma in Cystic Adenoma.—Cystic adenoma (Fig. 327) differs from chronic cystic mastitis (Fig. 339) only in its encapsulation. Our 12 cases diagnosed cancer in cystic adenoma were not encapsulated tumors, but circumscribed, resembling Fig. 337. In many of the cases the tumors were of long duration—5 to 25 years, with a history of

recent growth. In a few the tumor had been observed less than a year. The ages of the patients varied from twenty-nine to seventy-seven. Three cases were observed during lactation. A few of these cases undoubtedly were cancers, because the patients died of cancer. In these cases there were distinct areas of scirrhous or medullary carcinoma.

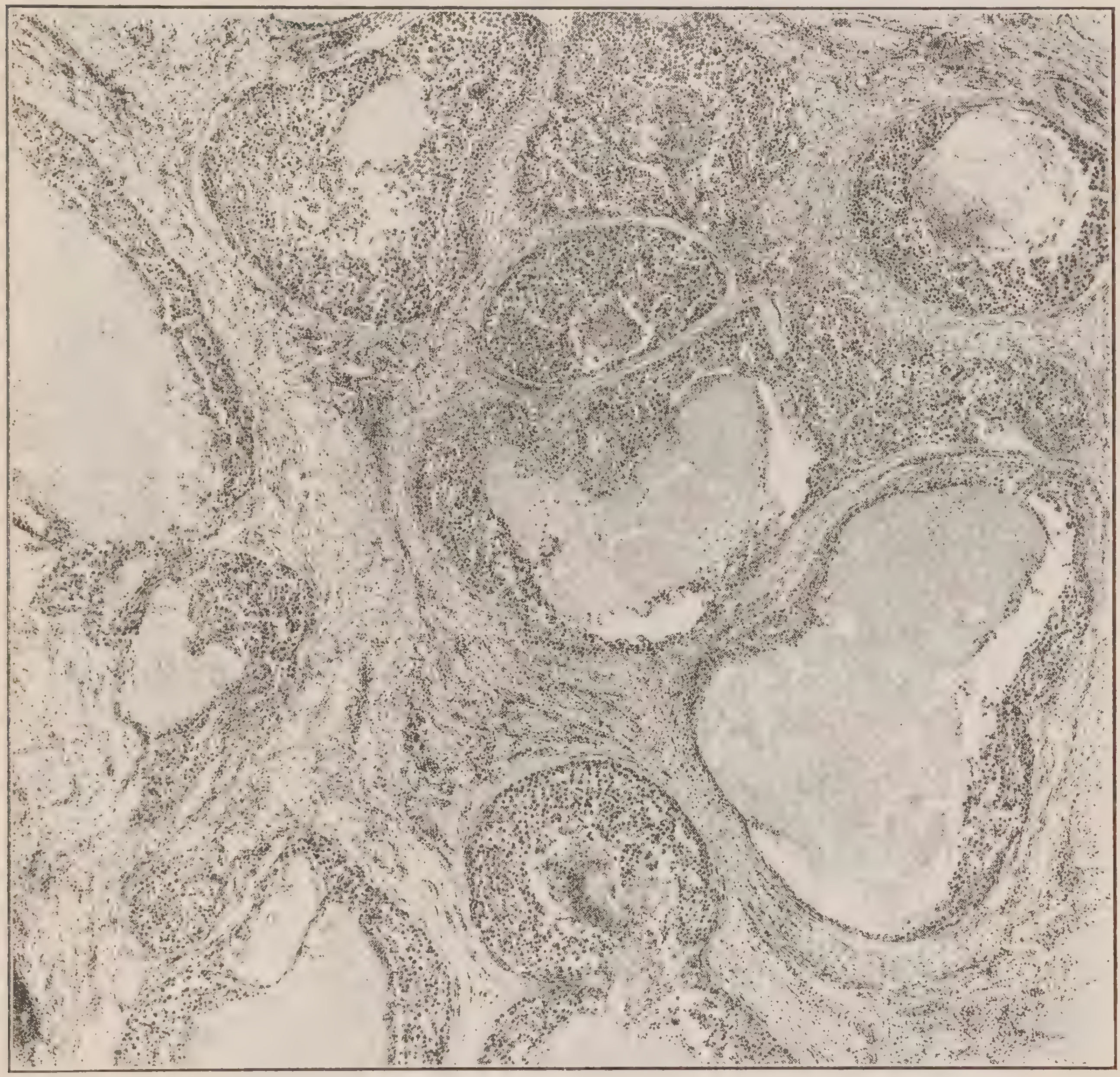

Fig. 346.—Duct cancer (comedo adenocarcinoma).

Pathol. No. 2815.—Operation in 1899, complete for cancer on both breasts. White, female, aged 52; tumor of one breast two years; recent ulceration with fungus formation. Small tumor in other breast. The patient lived 14 years and died of causes other than cancer.

Microscopically, they show the same histological picture, as already noted of cancer in chronic cystic mastitis (Figs. 341, 342 and 344).

It will always be safer when you meet a circumscribed tumor as pictured in Fig. 337 to treat it as malignant, even if it has a cystic appearance as shown in the tumor in Fig. 327.

FIG. 34.7—Colloid cancer. Circumscribed tumor involving a large portion of the breast beneath the nipple, showing infiltration of the breast beyond the tumor.

Pathol. No. 9733.—Complete operation for cancer in 1909. White, female, aged 31, tumor two years.

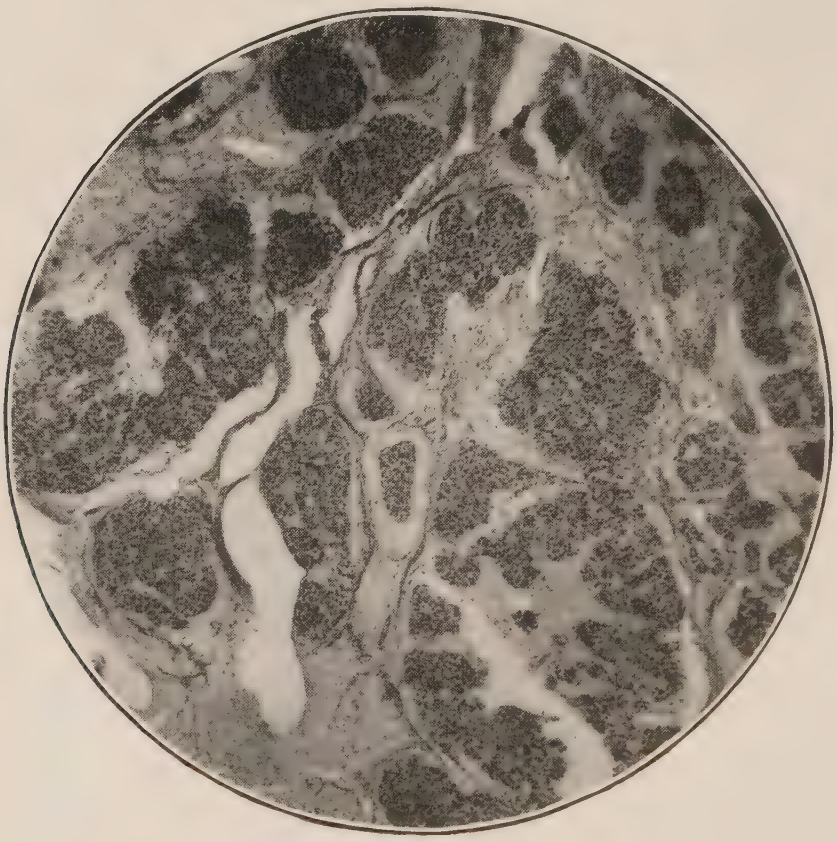

FIG. 348.—Colloid cancer.

Pathol. No. 4874.—Complete operation for cancer in 1903. White, female, aged 43, tumor nine months. 1916, 13 years, well.

Colloid Adenocarcinoma.—When explored, the gross appearance of this tumor (Fig. 347) is sufficiently characteristic to allow a positive diagnosis and indicate the immediate complete operation for cancer. I have received a number of colloid cancers in the laboratory for diagnosis the operator having unfortunately removed the tumor alone. In every instance there has either been recurrence, or death from cancer in spite of a second operation. The microscopic appearance is entirely different from any other lesion of the breast (Fig. 348).

In the past few days I have found in a young colloid cancer, areas of intracanalicular myxoma (Fig. 335) suggesting that this cancer may originate in this common benign tumor. But our evidence at the present time is too slight to reach a positive conclusion.

FIG. 349.—Scirrhous carcinoma. A somewhat circumscribed area, but showing distinct dots and lines in contrast with Fig. 337. Note also the slight retraction of the nipple. The surrounding breast is chiefly fat. There is a little stroma between the tumor and the nipple. There is no gross evidence of chronic cystic mastitis.
Pathol. No. 18840.—Recent case. For microscopic appearance see Fig. 308.

Malignant Papillomatous Cyst.—In my experience with 25 cases the malignant papillomatous cyst has shown clinical evidence of its malignancy by changes in the skin or nipple in over 85 per cent. of the cases. The probabilities are, therefore, when you explore a papillomatous cyst, that the tumor is still benign. The malignant papilloma has lost its papillomatous form and looks entirely different from the papilloma in Fig. 321. It has assumed a fungous appearance. In addition, the cyst wall at the base, and the breast beyond are infiltrated.

When one explores a breast tumor and finds a cyst partially, or completely, filled with a distinct papilloma, and at the base of the papilloma there is a distinct cyst wall separating the papilloma from the breast, and the breast beyond looks normal, excision of the cyst

with a zone of breast is a justifiable operation. In all other cases it is safer to perform the complete operation for cancer.

Scirrhous Carcinoma.—Until recently (Fig. 337) I felt that one should always recognize a scirrhous carcinoma at an exploratory incision by its hardness, by its gritty sensation to the knife, by its peculiar markings in fine dots and lines (Fig. 349).

In my past experience I had observed scirrhous cancer as a distinctly circumscribed area and as an infiltrating zone from the size of the end of the little finger up to a tumor involving the entire breast. In every instance the gross appearance was the same and the diagnosis confirmed by the microscopic section.

But now that women are seeking advice earlier we are seeing apparently for the first time a new group of tumors (see Fig. 337). Frozen sections will probably not help us in the differential diagnosis (see Fig. 338).

The circumscribed and infiltrating areas which resemble scirrhous carcinoma should at the present time be treated as malignant. I am confident that if we attempt to differentiate and be conservative in the smaller group too many mistakes will be made in performing incomplete operations for cancer. Apparently the circumscribed area is a precancerous lesion, and it will probably be safer never to be conservative in removing the lesion only, at least until we have had a much larger experience.

Cancer in Old Mastitis.—On page 607 I have referred to the possibility of a carcinoma developing in the residual scar after mastitis. In all of our cases the patients have been aware of the area of induration after mastitis from periods of 15 to 30 years. They have come under observation only after observing recent growth, with further changes in the skin and nipple. Recently I have had the opportunity to excise a chronic mastitis scar in the benign state. The cancer in all of these cases has always been of the scirrhous type, but in every instance we have been able to recognize with the microscope (Fig. 308) the remains of the old ducts surrounded by a zone of chronic inflammatory tissue.

Medullary Carcinoma.—This tumor, when small and clinically benign, is practically always a somewhat circumscribed area. I can imagine, but I have never seen, an encapsulated medullary carcinoma. It would probably then suggest an intracanalicular myxoma, and the frozen section would differentiate it. The medullary carcinoma, in contrast with scirrhus, is friable, little pieces can easily be picked out

FIG. 350.—Hemorrhagic medullary carcinoma. Photograph of section through the breast, showing circumscribed, cellular, hemorrhagic tumor.

The breast is rather fatty and fibrous, with no evidence of chronic cystic mastitis.

FIG. 351.—A tumor of the breast clinically malignant. The nipple is retracted, the skin dimpled. The center of the breast is occupied by an indurated mass.

Pathol. No. 2392.—Complete operation for cancer in 1898. No metastasis to axilla. 1916, 18 years well. White, female, aged 51; tumor two years and five months. Discharge from nipple 18 months.

The removed breast was the seat of an infiltrating scirrhus. No evidence of the parenchyma of the breast remaining.

with the knife. Now and then these tumors are very hemorrhagic (Fig. 350).

Sarcoma.—Metastatic sarcoma is so infrequent in the breast that it need not be considered here. I have seen one case among almost 1800 breast lesions. A correct diagnosis would not help, nor an incorrect one harm the patient. In this case the tumors were multiple, felt distinctly benign and appeared a few months after an operation for a malignant tumor of the ovary.

The most common sarcoma of the breast is a secondary development in an intracanalicular myxoma. The tumor as a rule is large, usually occupying more than half of the breast. The best rule is to treat all large intracanalicular myxomas on the diagnosis of sarcoma. The differential diagnosis from the large aberrant fibroadenoma can be made at the exploratory incision. The gross appearance of a fibroadenoma (see Fig. 336) should easily be differentiated from the intracanalicular myxoma.

The fibroadenoma as a rule is in younger women, and the larger aberrant tumor is always outside the breast. Apparently, however, differential diagnosis between these two forms has been difficult. I have mentioned this before (page 604).

The indigenous sarcoma of various types and mixed tumors containing cartilage and myxomatous tissue offer no difficulty at all at the exploratory incision; although circumscribed, their appearance will never be confused with that of any benign breast tumor.

Clinically Malignant Tumors (Fig. 351).—If we define retraction of the nipple, dimpling and other changes of the skin already described, and ulceration of the nipple as the usual signs of cancer, we have therefore the description of a clinically malignant tumor of the breast. All of these signs have been carefully described (page 576). We must also remember that these symptoms may now and then be associated with benign breast lesions. However, except in the few instances already defined, it seems safer to perform the complete operation for cancer without an exploratory incision.

Operation.—*No woman should be subjected to an operation* for a breast lesion, except for a lactation mastitis abscess, unless the surgeon is prepared to make the diagnosis at the exploratory incision and to perform the complete operation for cancer if indicated.

Now that women are seeking advice earlier I am inclined to think that a most painstaking clinical history and examination along the lines

laid down in the beginning of this article will be most helpful, and more so than in the past.

By this we must exclude a group (getting larger each day) in which operation is not indicated.

When the palpable breast lump is clinically benign the operation begins with an exploratory incision.

Exploratory Incision.—There is no objection to performing this under novocaine, with or without gas. The incision should be made from the areola out and over the tumor, pushing the breast and tumor toward the knife. Divide the skin and subcutaneous fat. Clamp the bleeding points. These clamps will do for retractors. Inspect the exposed breast tissue. Have a dry field. Often the blue dome of the simple benign cyst is exposed, and not infrequently in malignant tumors one can see and feel the infiltrated breast tissue at this point of the incision.

When the exposed breast looks and feels normal, cut through it, still pushing the tumor toward the knife; clamp the bleeding points; inspect the breast tissure carefully as it is divided. It is surprising how rapidly the benign cyst or encapsulated benign tumor is exposed to view, while in the malignant tumor one often feels that they are not being exposed as rapidly as expected.

This is explained by the fact that, in the benign cystic and solid tumors, the zone of breast is practically normal, and one palpates the tumor more easily through the breast tissue, while in the malignant tumor a very small area may feel so much larger than it really is, that when you cut into the palpable mass, you do not expose the real disease, because it is in the center of it.

In my own experience I have never missed a benign tumor at the exploratory incision, no matter how small. But on a few occasions I have had the greatest difficulty in isolating the very small scirrhous cancer, and a number of cases have come to me in which the carcinoma had been missed at the exploratory incision. Difficulty, therefore, in readily exposing the palpable tumor at the exploratory incision is suggestive of malignancy.

The moment you find signs of malignancy, disinfect the wound with pure carbolic acid followed by alcohol, and then use the cautery if you desire. I have tried the cautery for exploration of breast tumors and have so far found it unsatisfactory. Again, one can disinfect more rapidly with carbolic and alcohol than with the cautery.

Having disinfected the supposed malignant tumor, close the skin wound and proceed with the complete operation for cancer.

Some surgeons cut out a piece for frozen section, others cut out the entire tumor for inspection and frozen section. This has not been the practice nor the teaching of Dr. Halsted and I have no regrets, because I have always followed his precept and all my accumulated evidence is in favor of it.

It is surprising how rapidly one can differentiate at this exploratory incision. The benign cyst and the encapsulated tumor are recognized at once, and for these tumors a local operation is usually justifiable. In the other groups it is safer to perform the complete operation for cancer anyway. Of course, there are some exceptions. To recognize these exceptions requires great experience. If the majority follow the rule as stated, there should be no incomplete operations for cancer. There will be some complete operations for benign lesions. Up until the last few years in my observation this was done in about 10 per cent. of the benign lesions. In the last three years this has increased in experienced hands to 15 per cent.

An incomplete operation for cancer of the breast offers the patient little more probability of a cure than if there had been no operation at all. Operations in two stages do not compare in the results with one-stage operations.

Removal of Tumor.—Having exposed the benign cyst or the encapsulated benign tumor, remove it with a zone of breast through the incision made for exploration. Nothing is gained by enucleation. If one attempts to enucleate one may leave behind pieces of tumor tissue which may become foci of second growth. I have observed such recurrences after enucleation chiefly in mixed tumors of the parotid, but recently a number have come under my observation in which the tumor had been enucleated from the breast.

It is simpler to remove these tumors by cutting through the breast. It also gives one the opportunity to see the breast tissue.

Closure of the Wound.—The breast tissue should be approximated with interrupted, rapidly absorbing catgut, as a rule in three layers. The subcutaneous fat and the skin are approximated with fine silk. Buried silk and chromic catgut in breast tissue may give rise to a chronic mastitis resulting in a palpable tumor which may be very difficult to distinguish from a malignant one.

The breast wound should be closed most carefully, as hematoma usually results in a breakdown.

The dressing on the breast should be snug, fixed with adhesive straps and reinforced with a bandage.

When such details have been followed, the wounds heal, the patient and the surgeon are not worried by scar-tissue tumors or scar pain, and the subsequent function of the breast is never impaired. I have removed at one sitting three tumors from one breast and have operated twice on the same breast for a benign tumor without sacrificing the breast, or leaving any mutilation.

I have observed a few examples where after the removal of a benign breast tumor a huge defect could be seen and felt in the breast. The deformity is really more unsightly than the removal of the breast, and, of course, it is avoidable.

In my experience it is perfectly justifiable to confine the operation to the removal of the tumor only in simple cysts, papillomatous cysts, galactocele, cystic adenoma, fibroadenoma and small intracanalicular myxoma—that is the typical benign cyst and encapsulated benign tumors. It is justifiable to remove one or more of such tumors leaving the breast. I would be more inclined to remove the entire breast in multiple cystic adenomas than in any other form of multiple benign lesion.

In young girls one may palpate what seems to be a distinct tumor as a rule in the axillary quadrant. Yet, when one cuts down upon such an area there is no cyst, no encapsulated tumor, simply a zone of breast tissue to be distinguished from the surrounding white breast tissue by numerous pink, elevated dots. The youth of the patient helps in the differentiation. Microscopically, we find adenomatous hypertrophy (Fig. 312). Especially in young girls this peculiar lesion should be recognized, because excision of this zone is sufficient. The probabilities are that operation is not indicated at all, but when one feels a distinct tumor, we know it is safer to operate. But we must also recollect that we may not find a distinct tumor, but just an area of such hypertrophied breast.

The same condition may be present in older women at the cancer age; we feel an area of induration or even a distinct tumor, which as a rule is painful and tender. However, when we cut down upon this zone we are disappointed—there is neither a cyst, nor an encapsulated tumor, nor really any distinct disease. My records show a number of such cases in which the surgeon has been able to recognize the benignity of this lesion and has had the courage of his conviction. None of these patients lost the breast, nor have any of them suffered from

this wise conservatism. Unfortunately, however, in a larger group the operators have either been unable to make the diagnosis, or have lacked conviction. The operation has either been complete removal of the breast or that for cancer. Not one of these patients has died of cancer.

To the less experienced perhaps a frozen section would be very helpful in differentiating this non-encapsulated zone of adenomatous hypertrophy. Next to intracanalicular myxoma it is the easiest to recognize from its microscopic appearance (Fig. 312).

If one can recognize the chronic lactation mastitis with abscess, excision of the zone, if the lesion is single, is sufficient. My figures show that in at least 30 per cent. of the cases the chronic lactation mastitis has been treated on a diagnosis of malignancy.

It appears to be the uniform rule in tuberculosis of the breast to remove the entire breast, but in the beginning the tuberculosis may be a single focus, and I am confident that the time is coming when these younger women will not be unnecessarily mutilated for a small focus of tuberculosis in one breast.

Excision of Breast.—In some cases we can proceed with excision of the breast without an exploratory incision on account of the ability to make a pretty definite diagnosis of a benign lesion involving the entire breast.

In diffuse virginal and gravidity hypertrophy in which the enlargement has reached a certain stage one can proceed at once with the removal of one or both breasts. In mastitis with multiple sinuses and abscesses this operation is possible without an exploratory incision. In multiple tumors in women over 30 years of age when the breast is riddled with shot-like areas, the majority of surgeons excise the breast. This is also true when the sinus, induration and the history suggest tuberculosis.

In my experience the deliberate excision of one breast on the positive clinical diagnosis of a benign lesion is, with rare exceptions, a procedure fraught with danger; of mutilation for a benign lesion on one hand, or of an incomplete operation for cancer on the other. For all single palpable areas, and even for cases in which the breast shows multiple areas, it is on the whole safer to explore. The excision of the breast rests upon the character of the local lesion, the pathology of the surrounding breast, the age of the patient, and, to some extent, the wishes of the patient.

I have already described the local lesion in which it seems safe to confine our operation to the excision of the tumor only.

A number of patients, especially those who have nursed children, prefer to have the breast removed rather than run the risk of second operations. In all benign single lesions there is always the possibility of multiple foci which later grow.

Older women with huge, fatty breasts are probably protected by the complete removal of the breast, because in breasts of this kind it is difficult to exclude other lesions, and when cancer begins it spreads rapidly.

When the chronic cystic mastitis exposed in removing the single tumor is very extensive in the breast, patients will probably be saved second operations by the primary removal of the breast. This is such an easy condition to recognize that mistakes are rarely made, but many breasts are unnecessarily removed for this condition in its earlier stages.

In chronic cystic mastitis without large cysts, except in the early adenomatous stage, it is my opinion that it is safer to remove the entire breast. If one can recognize the chronic lactation mastitis and the multiple galactoceles, excision of the breast is sufficient, but in my experience the majority of surgeons have performed the complete operation for cancer when this disease was exposed at the exploration.

In every instance the breast after removal should be cut up in serial sections with a large amputating knife and studied for a possible area of cancer. Frozen sections can be made and in some instances may be helpful. In the presence of cancer the complete operation should follow at once.

When for any reason I have decided to excise the breast I always, by a most painstaking dissection, attempt to protect the individual by the complete removal of all breast tissue, because theoretically, any bit of breast tissue left behind might act as a focus for a subsequent benign or malignant tumor.

The complete excision of the breast is, on the whole, rather more difficult that the complete operation for cancer, because more skin is saved, and the dissection of this skin from the breast, to be properly done, is a delicate procedure, and very bloody, unless numerous bleeding points are clamped.

The nipple and areola are always removed. The area of skin beyond this varies with the size of the breast: the larger the breast the larger the area of skin; the larger the mass removed, the smaller the area of skin necessary to cover the defect.

The incision should begin over the rib near the rectus muscle in about the parasternal line and curve upward and outward to a point where the breast and pectoralis major muscle meet in the axilla; a second curved incision below encircles the nipple, the areola, an area of skin outlined for removal. These skin flaps should be dissected practically clean of subcutaneous fat over the breast tissue. It is simpler to dissect the upper flap first until the pectoralis major, and sometimes the rectus muscle, is exposed. It facilitates the dissection to remove the pectoral fascia with the breast. The dissection proceeds until the axillary fat is exposed. Now the skin fat on the outer side is dissected until the latissimus dorsi and serratus magnus muscles are exposed. This mass is then lifted up, and the connection with the chest wall divided from the lower point up toward the axilla. In this way the fat and fascia of the space below the axilla on the chest wall are removed with the breast, and the dissection is thus clean and complete as for cancer up to the base of the axilla.

Up to this point the dissection is just as complete as in the operation for cancer, except that the area of skin is a little smaller and the pectoralis major muscle is not removed.

In the opinion of the majority the removal of the pectoral muscle is made to allow a better exposure of the axilla, and, therefore, a more thorough dissection.

If the operation for the removal of the breast proceeds along this line up to this point, we really have nothing more to do, if early cancer is demonstrated, than to remove the pectoral muscle and complete the axillary dissection.

It is my rule, in the majority of cases to clamp the axillary attachments with the broad ligament clamp and make serial sections of the breast, searching for cancer. In two instances cancer was demonstrated, and the operation for cancer immediately followed. In one of these cases it is more than six years since this was done, and there has been no recurrence; the other case is recent.

If the operator decides that the breast condition is benign, the vascular attachments to the axillary area are ligated and the wound is closed.

It is my habit to close the wound with interrupted fine black silk. The wound after the excision of the breast usually fills with serum. I am inclined to think that this is due to torn lymph vessels, because this accumulation is very much less frequent after the complete operation for cancer when the skin wound is primarily closed.

When the technique has been good, I have been unable to tell whether it is better to drain these wounds or not. If you do not drain, the serum can be expressed after the fourth or fifth day. No drainage will absolutely prevent accumulation, and some of the serum will have to be expressed in any event. These wounds require the most careful after-dressing to prevent infection, and with each dressing the bandage must be snug.

There is another—and very important—reason for the complete removal of the breast along these lines. My figures show that some cases diagnosed adenocarcinoma have remained well and free from recurrence of the diseases from 5 to 16 years after the operation. The number of cases of this early type of disease will increase when women seek advice early after the first appearance of the tumor. At the present time we are not in a position to do such a restricted operation, if it is our opinion that the lesion is cancer. However, if one has decided to remove the breast, let it be done in this more radical way for the benefit of the patient. There is no more mutilation, or danger, nor is the period of convalescence longer or more uncomfortable; nor are the chances of a painful scar any greater.

Excision of Both Breasts.—I had hoped that our long and intensive study of the pathology of breast lesions in relation to the results after the different operations would throw some light on cases in which the pathology of one breast would indicate the removal of the other. But at the present time I do not feel justified in giving any rule. It seems safer to apply to the other breast the rules already stated.

The palpable lesion, single or multiple, in each breast is subjected to the same diagnostic scrutiny.

If a patient has a tumor in one breast, no definite tumor in the other, but multiple shot-like nodules or areas of induration, it is probably safer to remove both breasts, if the first breast removed is the seat of chronic diffuse mastitis without large cysts, or of multiple cystic adenoma.

When both breasts are removed at one or two operations, the technique as described should be employed for each breast.

Operation for Sarcoma.—When there is a tumor involving almost half or more of the breast and the skin over it is not involved, the chances are that it is not carcinoma, but that it is either a benign intracanalicular myxoma or some form of sarcoma. In these cases the breast will have to be sacrificed, and as most of these tumors are sarcoma, it is better to treat all as sarcoma.

The technique of the operation is very similar to that already described for the excision of the breast. The area of skin should be larger and should include all of the skin covering the palpable tumor. In addition, the pectoral muscle beneath the breast and tumor should be removed. Theoretically, there is no objection to performing the complete operation for cancer, but it seems unnecessary. In our early cases of sarcoma in intracanalicular myxoma in which the tumor and breast only were removed, recurrence in the pectoral muscle took place in every instance. Since we have removed the muscle there have been no recurrences. In a few of these cases we have also removed the axillary glands. These did not show metastasis.

T the present time we have never saved a sarcoma of the breast other than sarcoma in intracanalicular myxoma. The patients died of metastasis to the lungs.

Complete Operation for Cancer.—In this operation there is removed an area of skin, a wider area of subcutaneous fat, the major pectoral muscle, except its clavicular bundle; the minor pectoral muscle is either removed or divided, and there is a complete dissection of the axillary tissue without injury to the main vessels and nerves.

The most striking part of Halsted's first report was not the per cent. of ultimate cures, because the time of observation was too short, but the low per cent. of local recurrences in the scar, and even of regionary recurrences on the chest wall. The description of the technique of the operation in Halsted's first and subsequent reports may not have been entirely clear, but the operation as first performed by him was ideal, and all of his students who have followed his teaching will agree that his method was the first truly complete operation for cancer of the breast.

From a most painstaking study of the local growth of cancer in the breast and from the position of local and regionary recurrences I am convinced that the chest-wall dissection is the most essential feature of the operation. Now that patients are seeking advice earlier, the complete axillary dissection is becoming relatively less important.

Even in small malignant tumors of the breast there may be widespread dissemination of cancer cells through the channel of the gland ducts. I am inclined to think that this occurs before extensive lymphatic dissemination in the breast. For this reason, as described under excision of the breast, every particle of breast tissue must be removed.

Connective-tissue rich in lymphatics radiates between the skin and the breast beneath, and when cancer reaches the skin, it may disseminate rapidly within a considerable zone of skin. For this reason in all cancers of the breast with the slightest involvement of the skin the skin area removed should be larger, and with the extent of involvement of the skin the larger and larger should be the area of skin excised.

One should never see breast tissue during the operation, only fat, fascia and muscle.

In planning the area of skin to be removed the tumor, not the nipple, should be its center. In this zone of skin the nipple and areola should always be included. In thin patients with little subcutaneous fat always take a larger zone of skin, because in such instances it is more difficult to dissect the skin from the breast than when there is more fat. It is far better for the inexperienced to begin with the excision of a huge area of skin and restrict this as experience is gained, rather than the reverse.

Freedom from recurrence in the region of the scar does not depend upon the closure or the healing of the wound, but upon the extent of the surgeon's dissection in relation to the local extent of the disease.

I have had a large opportunity to compare the results of different methods of operation and different surgeons, and I am confident that the large number of the local recurrences is not due to the extensive local growth of the cancer at the time of the operation, but to the restricted zone of skin and subcutaneous tissue removed by the surgeon.

Skin-grafting can be done a week later with little or no anæsthesia at all.

In planning the operation always make it a little more extensive than the local conditions seem to indicate. The surgeon must watch himself all the time not to "cut corners," to remember that the object of this operation is to make the best attempt possible to get rid of the malignant disease.

It does not make much difference where one begins or where one ends in this operation or in what sequence the various steps follow each other, providing each step is well executed. In the majority of cases it seems simpler to dissect the upper skin flaps first, exposing the pectoralis major muscle. Except when the tumor is situated in the axillary zone, it is unnecessary to prolong the incision down the arm.

After exposing this muscle I prefer to make all of the skin dissection, except in the base of the axilla, until muscle is exposed. It facilitates most of the operation to prolong the incision down over the rectus. This helps in enlarging the exposure of the subcutaneous fat and later allows one to bring the skin flaps closer together.

Muscle.—The pectoralis major muscle is so divided that the clavicular bundle is left undisturbed. As the division extends upward toward the rib, push down the lymphatic tissue and vessels which lie between the two muscles. Then continue the division of the muscle along the sternum, clamping the intercostals. Extend the division down along the sternum to the rectus and clean the rectus and serratus magnus of all fat and fascia to be removed with the tumor mass.

Now inspect the axilla. If no glands can be felt, you know it is a favorable case. If glands are felt above the acromio-thoracic vessels and in the apex of the axilla, one must resect a V-shaped piece of the clavicular bundle of the pectoral up to the clavicle and make *en bloc* dissection of this muscle, the vessels, and all the tissue in the space between the clavicle and vessels in this area. In favorable cases this is unnecessary, and the acromio-thoracic vessels can be left undisturbed just as we leave the supraclavicular fossa out of the zone of dissection.

In proceeding with the axillary dissection I prefer, after inspection, to isolate the vessels and fat which pass from the apex of the axilla down over the minor into the major, clamp them and burn through with the cautery. This exposes the minor. The minor may be divided in favorable cases, and each half used as a retractor. In unfavorable cases it should be completely removed. In unfavorable cases the dissection of the acromio-thoracic area begins before the removal of the minor, as this gives more room for attacking the muscle. But in favorable cases when you divide the minor this is done first, and the dissection is begun at the apex of the axilla, first isolating the subclavian muscle over the vein.

I have always followed the example of Halsted and isolated the vessels separately, ligating with fine silk.

One cleans everything from the vein from the apex to the arm; then there is exposed the cavity between the subscapular muscle and the chest wall. In making this dissection one must use a combination of blunt sweeping with a piece of gauze as well as the knife. The process of cleaning everything, leaving only bare muscle, major

vessels and nerves, passes down over the teres major and latissimus dorsi until it strikes the subcutaneous fat at the base of the axilla. Having reached this point one can push the mass over into the wound and proceed with the dissection of the skin-flap over that area not included in the first and second step.

Closure of the Wound.—It is better to skin-graft than to use tension and have sloughing skin-flaps. I agree with Halsted that swelling and œdema of the arm are dependent chiefly upon wound infection, ever so slight. For this reason cover the vessels and make a good axillary fornix, then close the remainder of the wound, if you can, without tension; if not, skin-graft then or later, according to experience.

In a few cases where there is no axillary flap on account of the dissection necessary to remove a malignant tumor in the axillary quadrant, one can easily make a flap from the posterior skin area.

The direction of the skin incision in length is that described for the removal of the breast. The area of skin removed within this line varies according to the position of the tumor, the position of the breast, the size of the breast, and the thickness of the subcutaneous fat. It is impossible, and therefore would be futile to make one type of incision fit all cases.

Neck.—When the highest axillary glands are involved and one has made the V-shaped division of the clavicular bundle of the major, and the microscope shows these glands to be involved, the complete dissection of the supraclavicular glands should be done at a second operation.

It is quite true that the chances of a permanent cure in such cases are not more than about 6 per cent. However, when this operation is properly done there is rarely local recurrence, and many patients whose lives are not saved are made more comfortable, if this dissection is done at the proper time.

Supraclavicular Dissection.—From about the middle of the sterno-mastoid muscle make an incision down to the junction of the inner and middle thirds of the clavicle to join another incision which runs along the clavicle. Reflect the two flaps outlined by the above cuts. Expose and clean the sterno-mastoid down to the clavicle. Isolate and ligate the external jugular vein. Beginning high up, dissect all fatty tissue from the internal jugular vein downward to within 1 or 2 cm. of the apex of the triangular exposed area. From without inward clear the clavicle and subclavian vessels; by pulling on the mobilized mass of tissue the important dissection between the internal jugular

and the subclavian veins is completed. Lift the mobilized triangular mass so as to isolate and clamp its vascular attachments to the posterior muscles of the neck. On the left side lookout for the thoracic duct. At the base of the triangle the large number of vessels emerging from between the posterior muscles cause much bleeding unless they are isolated and separately clamped.

Excision of Vein.—Now and then in the axillary dissection the cancer is adherent to the axillary vein. There is no objection whatever to isolate and ligate a segment of this vein if necessary.

Hemorrhage.—When the tumor is on the sternal periphery of the breast and for this reason you are forced to a dissection close to ribs, intercostal muscles and sternum, you will experience difficulty in clamping and ligating the perforating intercostal vessels.

Should a clamp miss the vessel, do not attempt to re-clamp by pushing the instrument into the intercostal muscle, you may perforate the pleura. The hemorrhage can be checked by holding a bit of gauze there.

Recently in cases of this kind I have hastened and simplified matters by using the electric cautery knife. We now know this is a safer procedure when near cancer, and if one uses it slowly the vessels divided rarely require clamping.

Shock.—After a considerable comparative experience with nitrous-oxide gas anæsthesia and ether-drop, I prefer ether in the majority of cases of complete operation for cancer. Here there is no necessity for deep narcosis. Shock is rarely observed, and if one checks hemorrhage, it should never be fatal.

Mortality.—When the complete operation for cancer was extended to the complete supraclavicular dissection and skin-grafting at one sitting, the mortality increased from about ½ per cent. to 3. Now that this neck operation has been given up as a routine procedure and when done is always performed at a second operation, the mortality has fallen to less than ½ per cent.

Late Results.—In a short article of this kind there is no space to consider this phase of the subject. All our patients should be carefully watched, because even after complete operation for cancer there is the remaining breast to be looked after. Every one of these patients should be given the proper information for her own protection: "If you feel a lump return at once for inspection. No matter how well you feel, return for an examination at certain given intervals."

Function of the Arm.—In the first place good function is dependent upon healing without infection; second, upon early and continuous use.

INDEX

A

B

G

H

M

Q

R

T

U

V

W